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ABSTRACT

This teacher's guide contains nine units of instruction for a course on computer-assisted pipe drafting. The course covers the following topics: introduction to pipe drafting with CAD (computer-assisted design); flow diagrams; pipe and pipe components; valves; piping plans and elevations; isometrics; equipment fabrication drawings; piping design fundamentals; and plot plans and equipment layout. Each of the instructional units, which are keyed to similar student units of study, includes some or all of the following basic components of a unit of instruction: objective sheet, suggested activities for the teacher, answers to assignment sheets and written test, written test, unit evaluation form, teacher supplements, transparency masters, information sheets, assignment sheets, student supplements, and job sheets. All of the unit components focus on measurable and observable learning outcomes; they are designed for use in more than one lesson or class period of instruction. In addition to the units of study, the teacher's edition contains instruction for using the publication; a competency profile; an instructional and task analysis, a list of related academic and workplace skills; a tools, and an equipment and materials list. Contains 14 references. (KC)

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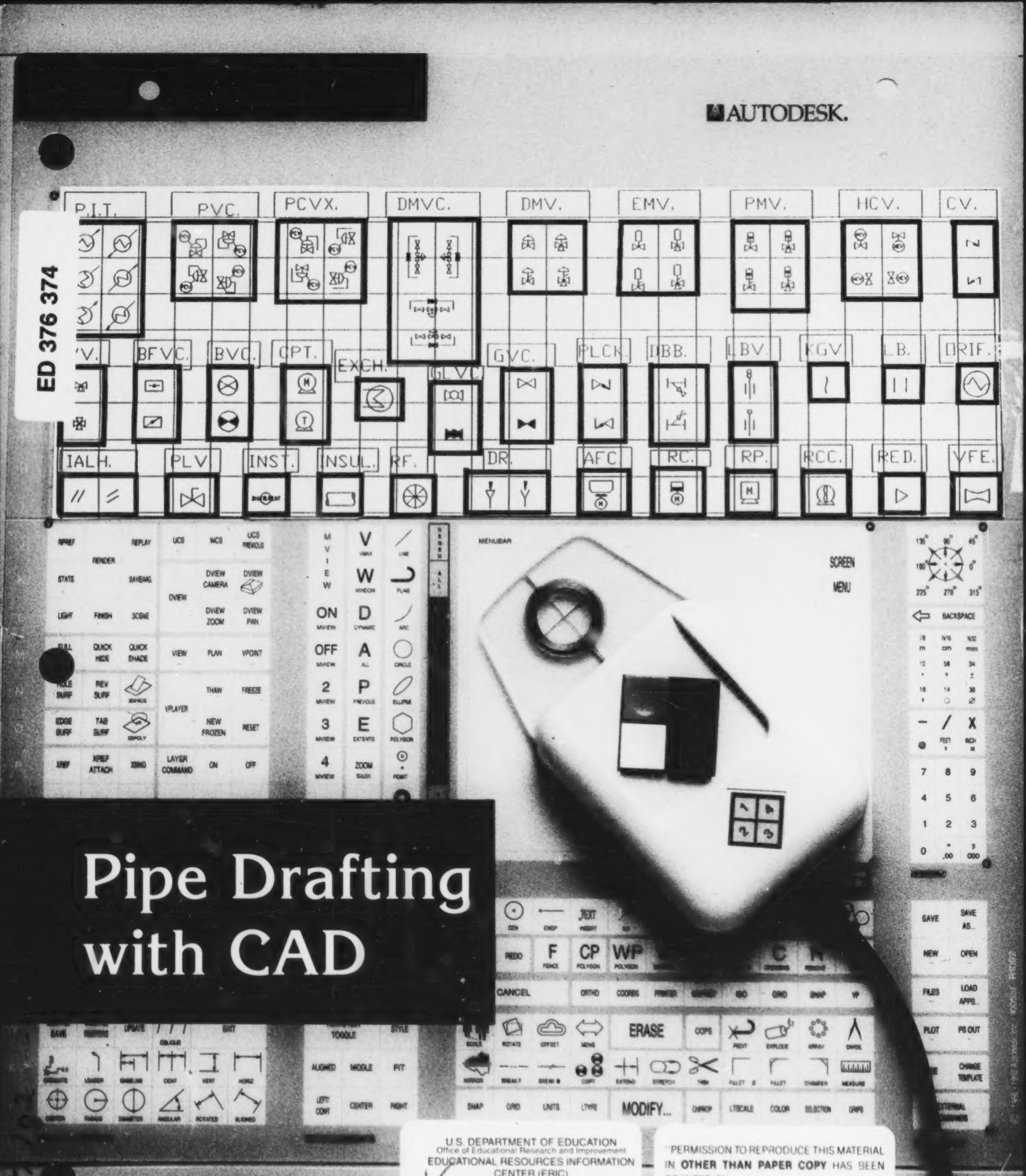
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Pipe Drafting with CAD

MAVCC

Teacher Edition

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Pipe Drafting With CAD

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Pipe Drafting With CAD

Teacher Edition

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Foreword

Pipe Drafting With CAD is much more than a revision of MAVCC's original *Pipe Drafting* text. The committee that met to plan the new book stressed the CAD element, and teaching students CAD is the prime objective of this new text. As the text progresses from unit to unit, students are encouraged to build their own pipe symbol library. In other situations, students who may still be at the board level of pipe drafting are reminded of the positive features of CAD, and challenged to perform assignment sheets at a CAD station. A **CAD Alert** at the beginning of an assignment explains to a student how much faster and easier it is to draw with CAD.

> **CAD Alert:** Because you will use this drawing again in the next assignment sheet, you can save a world of time by making this first drawing on a CAD system. The additions required in the next assignment can be made without redrawing this initial layout.

The committee also wanted this new text to have better graphic materials. As you read through the materials, you will find that almost all the graphics are new. In fact, almost all the graphics are items from industrial drafting sources and present installations that have actually been built. We hope this attention to the real world of pipe drafting will enhance student response to the many assignment sheets that reflect what pipe drafters do in industry.

Pipe drafting is certainly subject to the ups and downs of oil-related activities, but pipe drafters find challenging work in industrial applications of many kinds, and good pipe drafters still find good jobs. We hope this text not only teaches the craft of pipe drafting, but encourages students to size pipe and equipment, layout plot plans, and become a complete pro.

Most of all, we hope that the materials contribute to the quality of your program. Every effort has been made to make these materials readable and useable. The graphic impact of the numerous illustrations in the text should retain student interest and enhance instruction. As an instructor, you will need to motivate students by developing instructional strategies for localizing, individualizing, and supplementing the text.

As you work with materials, we hope you'll make notes of what we may have overlooked or items that are effectively presented. We appreciate opinions about our materials, and when those opinions come from instructors working with the text, they mean twice as much. Write or call us at MAVCC. We want to hear from you.

Sylvia Clark, Chairman
Board of Directors
Mid-America Vocational
Curriculum Consortium

Jim Steward
Executive Director
Mid-America Vocational
Curriculum Consortium

Acknowledgements

We thank the resource committee that reviewed the original MAVCC pipe drafting text and contributed their time and talent to planning *Pipe Drafting With CAD*. Those members are:

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Charles Carbonneau	Engineering Department Head, Lake Area Technical Institute, Watertown, South Dakota

We extend a special thank you to Crane Valves and to the Ladish Company for permission to reprint a large number of graphics that greatly enhance this effort. Thanks too to other manufacturers whose materials also contribute to the graphic impact of our text.

To the Oklahoma Department of Vocational and Technical Education, a special thank you to the personnel in word processing, art, and the print shop for their help with development and printing. Their contributions have been significant.

Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information such as the table of contents, foreword, and acknowledgements page, information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/ learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **Instructional/task analysis**—Provides a quick review of contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.
4. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and job sheets) according to related academic and workplace skills being reinforced. Skill areas reflected by skill groups, sub skills, and descriptions have been identified using *Workplace Basics: The Skills Employers Want*, developed by the American Society for Training and Development (ASTD) and the U.S. Department of Labor and adapted by MAVCC.
5. **Tools, equipment, and materials list**—Provides a comprehensive list of those items needed to successfully complete the assignment sheets and/or job sheets; assists administrator/teacher in determining program costs.
6. **Reference list**—Provides a comprehensive list of resources used in the development of this publication.

A glossary of terms may also be provided in the introductory materials depending on subject matter and committee recommendations.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

Use of This Publication

Instructional units

Pipe Drafting With CAD contains nine units of instruction. Each instructional unit in a teacher edition includes some or all of the following basic components of a unit of instruction: objective sheet, suggested activities for the teacher, answers to assignment sheets, answers to written test, written test, unit evaluation form, teacher supplements, transparency masters, information sheet, assignment sheets, student supplements, and job sheets.

All of the unit components focus on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period.
- Skills that must be demonstrated.
- Amount of class time needed for demonstrations.
- Amount of time needed for student practice.
- Supplementary materials, including print and nonprint media and equipment and supplies, that must be ordered.
- Resource people who must be contacted.

Objective sheet (Color code: White)

Each unit of instruction is based on performance objectives which state the goals for successful completion of the course. These performance objectives are stated in two forms: unit objectives which state the expected performance of each student after completion of the unit of instruction, and specific objectives which state what the student must do to reach the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Teachers should prepare for each unit by deciding how each objective can best be taught.

Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

Use of This Publication

Suggested activities (Color code: Pink)

This component is included only in the teacher edition. The suggested activities assist teachers during the preparation stage of the teaching/learning process by providing an instructional plan, teaching suggestions, and a list of supplemental resources. Ways to integrate academic and workplace skills have been included in the teacher suggestions, and skill areas have been noted in bold. (A table of academic and workplace skills with accompanying definitions has been provided on page xv.) The teacher should read the suggested activities before teaching the units and decide how each objective can best be taught. Time should also be allowed to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the teacher will vary according to the particular unit.

References used in the development of each unit are listed in the suggested-activities section, along with suggested supplemental resources that may be used to teach the unit. These materials can be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or objectives in the area covered.

Instructions for evaluating student performance on the job sheets are also included in the suggested-activities section. Teachers should select and discuss with students the rating scale that will be used.

Assignment and written test answers (Color code: Pink)

Assignment-sheet answers and written-test answers are designed to assist the teacher in evaluation of student performances.

Written test (Color code: Yellow)

This component provides criterion-referenced evaluation of every cognitive objective listed in the unit of instruction. The test appears in the teacher edition only, but duplication is permitted for student use. If objectives have been added, deleted, or modified, appropriate changes should be made on the written test. It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired.

Unit evaluation form (Color code: White)

This sheet provides teachers with a record of each students performance on a unit of instruction. It includes space for assignment sheet ratings, job sheet ratings, written test scores, and teacher comments. The unit evaluation form is included in the teacher edition only, but may be duplicated.

Teacher supplements (Color code: White)

This component is included only in the teacher edition. Teacher supplements are optional materials for the teacher to use. They have three purposes: to provide the teacher with higher level materials to stretch the advanced student, with remedial information or practice to assist the less-advanced student, and with state-of-the-art information in which the teacher may not have background or with information that is not readily available in other books. Some teacher supplements may be duplicated for student use and are marked accordingly.

Transparency masters (Color code: White)

Transparencies are included in the teacher edition only and are used to direct the students' attention to the topic of discussion. They may provide illustrations, charts, schematics, or additional information needed to clarify and reinforce objectives included in the unit of instruction.

Information sheet (Color code: Green)

The information sheet provides the content essential for meeting the cognitive (knowledge) objectives of the unit. Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide information for the teaching of each objective.

Student supplements (Color code: White)

Student supplements are included in the student edition. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment and/or job sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information may be evaluated in the completion of assignment sheets or job sheets.

Assignment sheets (Color code: Tan)

Assignment sheets provide students with pencil and paper activities that give students the opportunity to make practical application of the knowledge in the information sheet. Criteria are provided to objectively evaluate student performance.

Job sheets (Color code: Blue)

The job sheets provide criteria to objectively evaluate student performance, a list of required equipment and materials, and a step-by-step procedure for performing a psychomotor skill. The teacher should discuss the equipment and materials available in the classroom and/or laboratory and demonstrate the procedure prior to having students practice procedure. When a student is ready to be evaluated, the teacher should follow instructions for evaluating student performance which may be found in the teacher edition.

Job sheets are an important segment of each unit. Job sheets provide potential employers with a picture of the skills being taught during training and the performances that might reasonably be expected from an individual who has had this training.

Disseminating material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder or folder for the current unit of study. This is convenient for students taking the material home to study. Upon completion, each unit is then placed in a larger binder. Some teachers prefer to store the material by unit in filing cabinets or boxes until needed.

For best results, provide student materials for each student. Student editions contain objective sheets, information sheets, student supplements, assignment sheets, and job sheets. Students should be allowed to take their materials home at the end of the course.

Academic and Workplace Skills
(Classifications and Definitions)

Skill Groups	Sub Skills	Definitions
Learning Skills	Learning to learn	Developing ability to apply knowledge to other situations; knowing how to learn.
Foundation Skills	Reading	Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task.
	Writing	Communicating a thought, idea or fact in written form in a clear, concise manner.
	Math	Applying computation skills such as reasoning, estimation, and problem solving as they are actually used on the job.
	Science	Applying knowledge learned through study or practice that is based on scientific principles as they relate to specific tasks.
Communication Skills	Listening	Listening for content, conversation, long-term contexts, emotional meaning, and directions.
	Oral communication	Communicating a thought, idea, or fact in spoken form in a clear, concise manner.
Adaptability Skills	Creative thinking	Using imagination to create something new—i.e. an idea, invention, work of art.
	Problem solving (critical thinking)	Recognizing and defining problems, inventing, and implementing solutions, and tracking and evaluating results.
Personal Management Skills	Self-esteem	Developing self-confidence and creating a positive self-image.
	Motivation/goal setting	Setting and meeting defined goals and objectives.
	Personal and career development	Emphasizing self-direction by establishing and implementing a plan.
Group Effectiveness Skills	Interpersonal relations	Developing ability to maintain positive relations with others.
	Negotiation	Resolving conflict between two or more individuals.
	Teamwork	Working together in a group to reach a common goal.
Influence Skills	Organizational effectiveness	Adapting to the organization's goals, values, culture, and traditional modes of operation.
	Leadership	Directing/influencing group in performance of a specific task; accepting responsibility for others.

Pipe Drafting With CAD

Competency Profile

Name: ______________________________

Directions: Evaluate the student using the rating scale below. Write the appropriate number to indicate the degree of competency achieved. The descriptions associated with each of the numbers focuses on a level of student performance for each of the tasks listed. The written test scoreline is provided for optional teacher use. It may not be applicable in all cases.

Option A

Rating scale:
4 - Skilled - Can perform job with no additional training.
3 - Moderately Skilled - Has performed job during training program; limited additional training may be required.
2 - Limited Skill - Has performed job during training program; additional training is required to develop skill.
1 - Unskilled - Is familiar with process, but is unable to perform job.
0 - No Exposure - No information or practice provided during training program, complete training required.
NA - Non-applicable.

Option B

Yes - Can perform with no additional training
No - Is unable to perform satisfactorily

Unit 1: Introduction to Pipe Drafting With CAD

______ 1. Practice vertical, inclined, and CAD lettering.
______ 2. Practice isometric lettering.
______ 3. Measure with civil engineer and architect scales.
______ 4. Determine piping diameter, weight, and related information.
______ 5. Calculate piping math problems.
______ 6. Create a subdirectory on a CAD system.
______ 7. Draw piping symbols on a CAD system.
______ 8. ______________________________

______ Written Test Score

Unit 2: Flow Diagrams

______ 1. Identify parts of line numbers.
______ 2. Draw flow diagram equipment symbols.
______ 3. Draw instrumentation and electrical symbols.
______ 4. Draw a mechanical flow diagram with depropanizers.
______ 5. Draw a mechanical flow diagram with storage facilities.
______ 6. ______________________________

______ Written Test Score

Competency Profile

Unit 3: Pipe and Pipe Components

______1. Look up fitting dimensions and draw symbols.
______2. Construct single line drawings of screwed and socket weld pipe fittings.
______3. Construct single line drawings of welded pipe fittings.
______4. Construct double line drawings of welded pipe fittings.
______5. Complete dimensions for single line drawings of butt weld and screwed fittings.
______6. ____

______Written Test Score

Unit 4: Valves

______1. Determine data for check valves.
______2. Determine data for gate valves.
______3. Determine data for stainless steel valves.
______4. ____

______Written Test Score

Unit 5: Piping Plans and Elevations

______1. Draw a piping plan.
______2. Draw a piping section view.
______3. Draw a piping plan and elevation.
______4. ____

______Written Test Score

Unit 6: Isometrics

______1. Fill out a BOM and calculate lengths of pipe, Part A.
______2. Fill out a BOM and calculate lengths of pipe, Part B.
______3. Draw spool drawings from isometric A.
______4. Draw spool drawings from isometric B.
______5. Draw spool drawings from isometric C.
______6. ____

______Written Test Score

Competency Profile

Unit 7: Equipment Fabrication Drawings

______1. Locate nozzle mark numbers on a mechanical flow diagram.
______2. Calculate nozzle elevation dimensions from given mark numbers on a manufacturer's drawing.
______3. Calculate nozzle orientation in degrees from given mark numbers on a manufacturer's drawing.
______4. Locate information on a manufacturer's drawing.
______5. Complete a schedule of openings chart from a mechanical flow diagram.
______6. Use a pump specification sheet to find nozzle sizes on a flow diagram.
______7. ____

______Written Test Score

Unit 8: Piping Design Fundamentals

______1. Construct ladder and circular outline drawings.
______2. Lay out and pipe up a fractionation tower and pumps.
______3. ____

______Written Test Score

Unit 9: Plot Plans and Equipment Layout

______1. Draw a partial plot plan.
______2. Draw a plot plan.
______3. ____

______Written Test Score

COMMENTS: ____

____

____

____

____

Evaluator: ______________________ Date: ______________________

*** Permission to duplicate this profile is granted.**

Pipe Drafting With CAD

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 1: Introduction to Pipe Drafting With CAD

1. Terms and definitions
2. Types of lines
3. Guidelines for lettering
4. Types of working drawings
5. Type of drafting templates
6. Piping standards and their purposes
7. Pipe drafting reference materials and their functions
8. Practice vertical, inclined, and CAD lettering. (Assignment Sheet 1)
9. Practice isometric lettering. (Assignment Sheet 2)
10. Measure with civil engineer and architect scales. (Assignment Sheet 3)
11. Determine piping diameter, weight, and related information. (Assignment Sheet 4)

Unit 2: Flow Diagrams

1. Terms and definitions
2. The purposes of piping control systems
3. Types of flow diagrams and their applications
4. Common flow diagram piping symbols
5. Flow diagram equipment symbols
6. Characteristics of a sheet numbering system
7. Characteristics of a line numbering system
8. Guidelines for using an equipment numbering system

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do
Unit 2: (Cont.)	
9. Characteristics of an instrumentation numbering system	14. Identify parts of line numbers. (Assignment Sheet 1)
10. Guidelines for using a flow transfer numbering system	15. Draw flow diagram equipment symbols. (Assignment Sheet 2)
11. Types of control systems	16. Draw instrumentation and electrical symbols. (Assignment Sheet 3)
12. Steps in operation of a typical level control	17. Draw a mechanical flow diagram with depropanizers. (Assignment Sheet 4)
13. Guidelines for laying out flow diagrams	18. Draw a mechanical flow diagram with storage facilities. (Assignment Sheet 5)
Unit 3: Pipe and Pipe Components	
1. Terms and definitions	
2. Types of metallic pipe materials and their applications	
3. Nonmetallic pipes and their applications	
4. Types of pipes and their manufacturing methods	
5. Pipe end preparations, their characteristics and uses	
6. How to reference and specify pipe sizes and dimensions	
7. Types of flanges	
8. Types of flange facings and their characteristics	

Instructional/Task Analysis

Related Information: What the Student Should Know	**Application: What the Student Should Be Able to Do**
Unit 3: (Cont.)	
9. Types of gaskets and gasket materials	15. Look up fitting dimensions and draw symbols. (Assignment Sheet 1)
10. Flange bolting requirements 11. Welded fitting and flange symbols	16. Construct single line drawings of screwed and socket weld pipe fittings. (Assignment Sheet 2)
12. Threaded symbols 13. Guidelines for drawing pipe	17. Construct single line drawings of welded pipe fittings. (Assignment Sheet 3)
14. Guidelines for drawing pipe components	18. Construct double line drawings of welded pipe fittings. (Assignment Sheet 4)
	19. Complete dimensions for single line drawings of butt weld and screwed fittings. (Assignment Sheet 5)
Unit 4: Valves	
1. Terms and definitions	
2. Primary functions of valves	
3. Basic parts of a valve	
4. Gate valves and their characteristics	
5. Globe valves and their characteristics	
6. Check valves and their characteristics	
7. Angle valves and their characteristics	
8. Needle valves and their characteristics	

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do

Unit 4: (Cont.)

9. Y-pattern valves and their characteristics
10. Butterfly valves and their characteristics
11. Safety and relief valves and their characteristics
12. Diaphragm valves and their characteristics
13. Ball valves and their characteristics
14. Plug valves and their characteristics
15. Applications of steel and steel alloys
16. Valve body materials and their characteristics
17. Types of bonnet assemblies and their applications
18. Inlet/outlet connections and their applications
19. Types of stems and their characteristics
20. Types of valve actuators
21. Factors to consider when selecting a valve actuator
22. Valve symbols
23. Abbreviations for describing valve body materials

Instructional/Task Analysis

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do
Unit 4: (Cont.)	
24. Abbreviations for valve pressure ratings	28. Determine data for check valves. (Assignment Sheet 1)
25. Abbreviations for operating mechanisms	29. Determine data for gate valves. (Assignment Sheet 2)
26. Abbreviations for facings, disks, and joints	30. Determine data for stainless steel valves. (Assignment Sheet 3)
27. Abbreviations for end joints	
Unit 5: Plans and Elevations	
1. Terms and definitions	12. Draw a piping plan. (Assignment Sheet 1)
2. Dimensions for plan and elevation coordinate systems	13. Draw a piping section view. (Assignment Sheet 2)
3. Abbreviations used in piping plans and elevations	14. Draw a piping plan and elevation. (Assignment Sheet 3)
4. Pipe hangers and their correct uses	
5. Pipe supports and their correct uses	
6. Concrete foundations	
7. Pipe racks	
8. Guidelines for placing pipe on racks	
9. Methods of providing piping flexibility and their applications	
10. Types of insulations and their applications	
11. Abbreviations for types of insulation	

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 6: Isometrics

1. Terms and definitions
2. Purposes of isometrics and spool drawings
3. Information on the drawing side of an isometric/spool drawing
4. Information on the BOM side of an isometric/spool drawing
5. Single line isometric symbols
6. Isometric fitting representation
7. Correct and incorrect procedures for dimensioning isometrics
8. Guidelines for dimensioning angle and rolled offsets
9. Preferred method to place a north arrow
10. How to letter an instrumentation balloon
11. Drawing connecting lines and numbers
12. Guidelines for drawing and placing vents and drains
13. Guidelines for drawing and placing shop and field erection marks
14. Drawing and noting dummy supports
15. Fill out a BOM and calculate lengths of pipe, Part A. (Assignment Sheet 1)
16. Fill out a BOM and calculate lengths of pipe, Part B. (Assignment Sheet 2)
17. Draw spool drawings from isometric A. (Assignment Sheet 3)
18. Draw spool drawings from isometric B. (Assignment Sheet 4)
19. Draw spool drawings from isometric C. (Assignment Sheet 5)

Instructional/Task Analysis

Related Information: What the Student Should Know

Application: What the Student Should Be Able to Do

Unit 7: Equipment Fabrication Drawings

1. Terms and definitions
2. Equipment types and their applications
3. Information included on an equipment fabrication drawing
4. Information found on a schedule of openings chart
5. How to transfer information from a mechanical flow diagram to an equipment drawing
6. Characteristics of datum dimensioning of elevation views
7. Characteristics of dimensioning on orientation views
8. Noting nozzle and coupling elevation, orientation, and projection
9. Types of pumps and their characteristics
10. Selecting and sizing pumps
11. Tubular heat exchangers

12. Locate nozzle mark numbers on a mechanical flow diagram. (Assignment Sheet 1)
13. Calculate nozzle elevation dimensions from given mark numbers on a manufacturer's drawing. (Assignment Sheet 2)
14. Calculate nozzle orientation in degrees from given mark numbers on a manufacturer's drawing. (Assignment Sheet 3)
15. Locate information on a manufacturer's drawing. (Assignment Sheet 4)
16. Complete a schedule of openings chart from a mechanical flow diagram. (Assignment Sheet 5)
17. Use a pump specification sheet to find nozzle sizes on a flow diagram. (Assignment Sheet 6)

Unit 8: Piping Design Fundamentals

1. Terms and definitions
2. General rules for sizing and dimensioning control station components
3. Locating control valves
4. General arrangement of fittings in pump piping

Instructional/Task Analysis

Unit 8: (Cont.)

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do
5. Designing and dimensioning exchanger or reboiler piping	12. Construct ladder and circular outline drawings. (Assignment Sheet 1)
6. Design and layout of piping for fired heaters	13. Lay out and pipe up a fractionation tower and pumps. (Assignment Sheet 2)
7. Layout of compressor piping	
8. Turbine inlet and exhaust piping	
9. Designing piping for columns, vessels, and storage tanks	
10. Liquid level instruments	
11. Drawing ladders and platforms	

Unit 9: Plot Plans and Equipment Layout

Related Information: What the Student Should Know	Application: What the Student Should Be Able to Do
1. Terms and definitions	10. Draw a partial plot plan. (Assignment Sheet 1)
2. Information found on an existing contour drawing	11. Draw a plot plan. (Assignment Sheet 2)
3. Characteristics of a finished contour drawing	
4. Information found on a plot plan	
5. The purposes of a plot plan	
6. Characteristics of an area key index plan	
7. Characteristics of an equipment layout sheet	
8. Characteristics of an underground key index plan	
9. Characteristics of a firewater and fire fighting equipment plan	

Related Academic and Workplace Skills For *Pipe Drafting With CAD*

Task	Skill Group	Sub Skill	Description
Unit 1: Introduction to Pipe Drafting With CAD			
Practice vertical, inclined, and CAD lettering. (A.S. 1)	Foundation Skills	Science	Applies drafting standards to a task
Practice isometric lettering. (A.S. 2)	Foundation Skills	Science	Applies drafting standards to a task
Measure with civil engineer and architect scale. (A.S. 3)	Foundation Skills	Math	Uses mathematical references to compute a measurement
Determine piping diameter, weight, and related information. (A.S. 4)	Foundation Skills	Math	Uses mathematical formulas to compute physical properties of pipe
Calculate piping math problems. (A.S. 5)	Foundation Skills	Math	Applies mathematical formulas to find physical properties of pipe forms
Create a subdirectory on a CAD system. (A.S. 6)	Foundation Skills	Science	Applies knowledge of software to a computer application
Draw piping symbols on a CAD system. (A.S. 7)	Adaptability Skills	Creative thinking	Combines imagination with computer knowledge to create a working reference
Unit 2: Flow Diagrams			
Identify parts of line numbers. (A.S. 1)	Foundation Skills	Science	Applies learned principles to a workplace task
Draw flow diagram equipment symbols. (A.S. 2)	Foundation Skills	Science	Applies knowledge of symbols to a workplace drawing
Draw instrumentation and equipment symbols. (A.S. 3)	Foundation Skills	Science	Applies knowledge of symbols to a workplace drawing
Draw a mechanical flow diagram with depropanizers. (A.S. 4)	Foundation Skills	Science	Applies knowledge of symbols to a workplace drawing
Draw a mechanical flow diagram with storage facilities. (A.S. 5)	Foundation Skills	Science	Applies knowledge of symbols to a workplace drawing
Unit 3: Pipe and Pipe Components			
Look up fitting dimensions and draw symbols. (A.S. 1)	Foundation Skills	Reading/science	Comprehends written materials and applies learned knowledge to complete a task
Construct single line drawings of screwed and socket weld pipes. (A.S. 2)	Foundation Skills	Science	Applies learned knowledge to a workplace task

Related Academic and Workplace Skills

Unit 3: (Cont.)

Construct single line drawings of welded pipe fittings. (A.S. 3)	Foundation Skills	Science	Applies learned knowledge to a workplace task
Construct double line drawings of welded pipe fittings. (A.S. 4)	Foundation Skills	Science	Applies learned knowledge to a workplace task
Complete dimensions for single line drawings of butt weld and screwed fittings. (A.S. 5)	Foundation Skills	Science	Applies learned knowledge to a workplace task

Unit 4: Valves

Determine data for check valves. (A.S. 1)	Foundation Skills	Reading	Comprehends written information to confirm a technical reference
Determine data for gate valves. (A.S. 2)	Foundation Skills	Reading	Comprehends written information to confirm a technical reference
Determine data for stainless steel valves. (A.S. 3)	Foundation Skills	Reading	Comprehends written information to confirm a technical reference

Unit 5: Piping Plans and Elevations

Draw a piping plan. (A.S. 1)	Foundation Skills	Science	Applies learned knowledge to complete a drawing
Draw a piping section view. (A.S. 2)	Foundation Skills	Science	Applies learned knowledge to complete a drawing
Draw a piping plan and elevation. (A.S. 3)	Foundation Skills	Science	Applies learned knowledge to complete a working drawing

Unit 6: Isometrics

Fill out a BOM and calculate lengths of pipe, Part A. (A.S. 1)	Foundation Skills	Writing/math	Calculates pipe lengths and transcribes technical data
Fill out a BOM and calculate lengths of pipe, Part B. (A.S. 2)	Foundation Skills	Writing/math	Calculates pipe lengths and transcribes technical data
Draw spool drawings from Isometric A. (A.S. 3)	Foundation Skills	Science	Applies learned knowledge to create a working drawing
Draw spool drawings from Isometric B. (A.S. 4)	Foundation Skills	Science	Applies learned knowledge to create a working drawing
Draw spool drawings from Isometric C. (A.S. 5)	Foundation Skills	Science	Applies learned knowledge to create a working drawing

Related Academic and Workplace Skills

Unit 7: Equipment Fabrication Drawings

Locate nozzle marks on a mechanical flow diagram. (A.S. 1)	Foundation Skills	Reading	Comprehends and interprets a working drawing
Calculate nozzle elevation dimensions from given mark numbers on a manufacturer's drawing. (A.S. 2)	Foundation Skills	Reading	Comprehends and interprets a working drawing
Calculate nozzle orientation in degrees from given mark numbers on a manufacturer's drawing. (A.S. 3)	Foundation Skills	Reading/math	Comprehends and interprets a working drawing
Locate information on a manufacturer's drawing. (A.S. 4)	Foundation Skills	Reading	Comprehends and interprets technical information on a working drawing
Complete a schedule of openings chart from a mechanical flow diagram. (A.S. 5)	Foundation Skills	Writing/science	Applies drafting principles and transcribes technical information
Use a pump specification chart to find nozzle sizes on a flow diagram. (A.S. 6)	Foundation Skills	Reading	Comprehends a technical reference

Unit 8: Piping Design Fundamentals

Construct ladder and circular platform outline drawings. (A.S. 1)	Foundation Skills	Science	Applies learned knowledge to complete a working drawing
Lay out and pipe up a fractionation tower and pumps. (A.S. 2)	Foundation Skills	Science	Applies learned knowledge to complete a working drawing

Unit 9: Plot Plans and Equipment Layout

Draw a partial plot plan. (A.S. 1)	Foundation Skills	Science	Applies working knowledge to complete a working drawing
Draw a plot plan. (A.S. 2)	Foundation Skills	Science	Applies working knowledge to complete a working drawing

Tools, Equipment, and Materials List

Basic tools for board work

Architect, metric, and civil engineer scales
Drafting brush
Drafting machine with scales, parallel bar, or T-square with adjustable triangle
Drawing media and drafting tape
Drawing pencils, pencil pointer, lead and lead holder, lead pointer
Drawing table or surface
Eraser and shield
Isometric grid paper
Lettering guide
Lettering set (such as Leroy)
Sandpaper pad
Technical pen set
Templates for flow, circle, isometric ellipse, instrumentation, valves pipe fittings, and isometric piping
Triangles, campass, divider, protractor, and curves

CAD-related hardware and software

Cad workstation
Dot matrix and/or laser printer
Pipe symbol libraries as available
Plotter
Software by Autocad or equivalent

Required references

Examples of pipe and pipe related drawings, especially of local installations
Manufacturers' catalogs
Pipe fitting manuals such as those published by Crane or Ladish
Reference materials from ANSI, ASME, and API

References

Alvin Company Catalog, M4. Arlington, TX: Alvin Company, 1992.

ANSI/ASME Y32.2.3-1949 (R1988), Graphical Symbols for Pipe Fittings, Valves, and Piping. New York: American National Standards Institute, 1988.

ANSI Y32.11-1961 (R1985), Graphic Symbols for Flow Diagrams in the Petroleum and Chemical Industries. New York: American National Standards Institute, 1961 Reaffirmed 1985.

CADalyst. Bellingham, WA: Cadalyst Publications, Ltd., 1992.

Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

Engineering Data. Chicago: The Crane Company, 1992.

Engineering Standards. Tulsa, OK: Crest Engineering, Inc., 1973.

Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division, McGraw Hill Book Company, 1981.

Ladish Piping Components. Cudahay, WI: The Ladish Company, 1993.

Publication AC11RM, AutoCAD Reference Manual. New York: Autodesk Inc., 1990.

Type 1066 and 1066 SR On-Off Piston Rotary Actuators. Marshalltown, IA: Fisher Controls International, 1984.

Types 7 SA and 7 SAR Electromechanical Actuators. Marshalltown, IA: Fisher Controls International, 1980.

Weaver, Rip. *Process Piping Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

Weaver, Rip. *Process Piping Drafting, Vols. 1 & 2*, 8th ed. Houston, TX: Gulf Publishing Company, 1990.

Introduction to Pipe Drafting With CAD
Unit 1

Objective Sheet

Unit Objective

After completing this unit, the student should be able to measure with drafting scales, determine piping diameter, weight, and other calculations, solve pipe-related math problems, and create a subdirectory and draw piping symbols on a CAD workstation. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to pipe drafting with CAD with their correct definitions.
2. Identify types of lines.
3. Complete statements concerning guidelines for lettering.
4. Match types of working drawings with their definitions.
5. Identify common types of drafting templates.
6. Match piping standards with their purposes.
7. Match pipe drafting reference materials with their functions.
8. Practice vertical, inclined, and CAD lettering. (Assignment Sheet 1)
9. Practice isometric lettering. (Assignment Sheet 2)
10. Measure with civil engineer and architect scales. (Assignment Sheet 3)
11. Determine piping diameter, weight, and related information. (Assignment Sheet 4)

Objective Sheet

12. Calculate piping math problems. (Assignment Sheet 5)
13. Create a subdirectory on a CAD system. (Assignment Sheet 6)
14. Draw piping symbols on a CAD system. (Assignment Sheet 7)

Introduction to Pipe Drafting With CAD
Unit 1

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan for enrichment of exceptional students as well as accommodation of special needs students.
4. Make transparencies from the transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objective:

   TM 1—Mechanical Flow Sheet (Objective 4)
   TM 2—Plot Plan Initial Layout (Objective 4)
   TM 3—Plot Plan—Equipment Layout (Objective 4)
   TM 4—Piping Plan View (Objective 4)
   TM 5—Piping Sections (Objective 4)
   TM 6—Special Fabrication Detail Drawing (Objective 4)

5. Obtain films, videotapes, and other resources to supplement instruction of this unit. See ordering information in the Suggested Supplemental Resources section that follows.
6. Develop teaching plan. Adjust for different learning styles.
7. Make copies of Unit Evaluation Form.

Delivery and Application

8. Provide students with unit of instruction.
9. Discuss unit and specific objectives.
10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
11. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Suggested Activities

Evaluation

12. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

13. Make copies of the written test. Add or modify test items as needed.

14. Give written test.

15. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments.

16. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. When teaching Objective 2, emphasize the importance of layers, colors, and planes to differentiate between lines. Skill areas: **Adaptability skills, creative thinking**.

2. When teaching Objective 3, emphasize the importance of a company standard for fonts and sizes. Skill areas: **Communications skills, listening**.

3. When demonstrating assignment sheets 1, 2, and 3, emphasize the importance of good lettering practice. Review MAVCC's *Basic Drafting* for guidelines. Skill areas: **Foundation skills, reading**.

4. Student supplements in this unit will permit students to complete assignment sheets 4 and 5 if no other pipe reference material is available. Skill areas: **Foundation skills, reading**.

5. When monitoring student progress on Job Sheets 1 and 2, stress accuracy of drawing and file placement. Skill areas: **Personal management skills, motivation/goal setting**.

6. Show available video on CAD commands, and review as necessary before allowing students access to a CAD workstation. Skill areas: **Foundation skills, science**.

Suggested Activities

7. Student supplements in this unit will help students successfully complete the assignment sheets, but encourage students to reference these supplements as needed as they study other units in this text. The information contained in the supplements is taken from manufacturers' publications and is typical of materials that pipe drafters work with almost daily. Skill areas: **Foundation skills, learning to learn**.

Resources Used in Developing This Unit

1. *Alvin Company Catalog, M4.* Arlington, TX: Alvin Company, 1992.
2. *ANSI/ASME Y32.2.3-1949 (R1988), Graphical Symbols for Pipe Fittings, Valves, and Piping.* New York: American National Standards Institute, 1988.
3. *CADalyst.* Bellingham, WA: Cadalyst Publications, Ltd., 1992.
4. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-American Vocational Curriculum Consortium, 1983.
5. *Engineering Data.* Chicago: The Crane Company, 1992.
6. *Engineering Standards.* Tulsa, OK: Crest Engineering, Inc., 1973.
7. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division, McGraw Hill Book Company, 1981.
8. *Ladish Pipeline Fittings and Flanges.* Cudahay, WI: The Ladish Company, 1993.
9. *Ladish Piping Components.* Cudahay, WI: The Ladish Company, 1993.
10. *Publication AC11RM, AutoCAD Reference Manual.* New York: Autodesk Inc., 1990.
11. Weaver, Rip. *Process Pipe Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Supplemental Resources

1. Weaver, Rip. Video Tape Series: Process Pipe Drafting, Piping Familiarization, Piping Pointers, and Blueprint Reading Basics. Gulf Publishing Company, Book Division, P.O. Box 2608, Houston, TX 77252-2608.

Suggested Activities

2. Cadpipe Ortho, Iso, P&ID Forms, Software Package, Digitizer Driven. Endeco Engineering Ltd., 200 Carnegie Drive, St. Albert, Alberta T8N 5A7 CANADA, (403) 459-9041.

3. Pro-Pipe, Software Package, Isometric pipe drafting package. Industrial Graphics, P.O. Box 509, Branch, MI 49402, (616) 898-2701.

4. Piping Schematic Symbols Library. Drafting Technology Services, 2425 Nowata Place, Suite 202, Bartlesville, OK 74006, (918) 335-2480.

Introduction to Pipe Drafting With CAD
Unit 1

Answers to Assignment Sheets

Assignment Sheet 1

Problem 1: Construct ⅛″ vertical Gothic letters and numerals.

1½″ 150# THREADED CPLG (TYP 3 PL) 1½"-150# THREADED CPLG.

BOP EL 114′-6¾″ B.O.P. EL. 114'-6¾" (TYP. 3 PL.)

MATCH LINE SEE DWG NO 133 MATCH LINE SEE DWG. NO. 133

E 5125′-0″ E-140 A & B E5125'-0" E-140A & B

STABILIZER STABILIZER

NOTE:

1. THIS SKID IS DRAWN SHOWING
UNION HDL 12″ × 14″ × 19″
PUMP AND IS SUBJECT TO CHECK
ON RECEIPT OR CERTIFIED PRINTS
FROM PURCHASED VENDOR.

NOTE:

1. THIS SKID IS DRAWN SHOWING
UNION HDL 12" × 14" × 19"
PUMP AND IS SUBJECT TO CHECK
ON RECEIPT OF CERTIFIED PRINTS
FROM PURCHASED VENDOR

Problem 2: Construct ¼″ vertical Gothic letters and numerals.

E-30 E-30 V-21 V-21 P-1 P-1 V-41 V-41

STABILIZER CRUDE PRODUCT COOLER

STABILIZER CRUDE PRODUCT COOLER

STORAGE TANK AFTERCOOLER

STORAGE TANK AFTERCOOLER

Answers to Assignment Sheets

Problem 3: Construct ⅛" inclined Gothic letters and numerals.

1½" 150# THREADED CPLG (TYP 3 PL)	1½"-150# THREADED CPLG. (TYP. 3 PL.)
BOP EL 114'-6¾"	BOP EL 114'-6¾"
MATCH LINE SEE DWG NO 133	MATCH LINE SEE DWG. NO. 133
E 5125'-0" E-140 A & B	E5125'-0" E-140 A & B
STABILIZER	STABILIZER
TOS 115'-6¼"	TOS 115'-6¼"
EL 128'-8"	EL. 128'-8"

NOTE:

1. THIS SKID IS DRAWN SHOWING
UNION HDL 12" × 14" × 19"
PUMP AND IS SUBJECT TO CHECK
ON RECEIPT OR CERTIFIED PRINTS
FROM PURCHASED VENDOR.

NOTE:
1. THIS SKID IS DRAWN SHOWING
UNION HDL 12"×14"×19"
PUMP AND IS SUBJECT TO CHECK
ON RECEIPT OF CERTIFIED PRINTS
FROM PURCHASED VENDOR

2. FOR INSULATION REQUIREMENT CONSULT
INSULATION SPEC. 8.1.

2. FOR INSULATION REQUIREMENT
CONSULT INSULATION SPEC. 8.1.

Problem 4: Construct ¼" vertical Gothic letters and numerals.

E-30 E-30 V-21 V-21 P-1 P-1 V-41 V-41

PRODUCT COOLER

PRODUCT COOLER

AFTERCOOLER

AFTERCOOLER

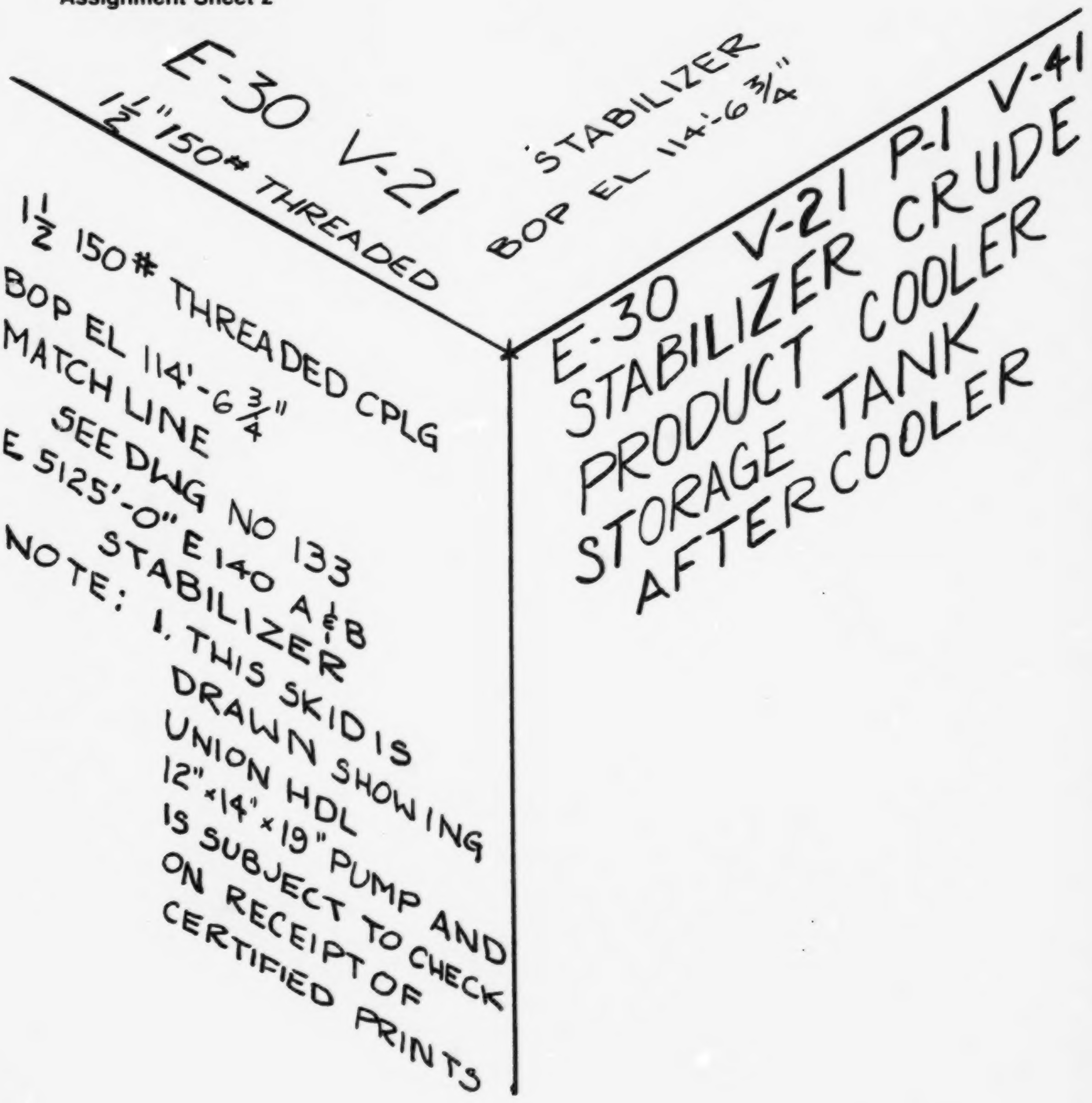
ACCESS AREA

ACCESS AREA

Answers to Assignment Sheets

Problem 5: Student drawings will vary depending on capability of CAD system and software.

Assignment Sheet 2


E-30 V-21
1½" 150# THREADED
STABILIZER
BOP EL 114'-6¾"
1½ 150# THREADED CPLG
BOP EL 114'-6 ¾"
MATCH LINE
SEE DWG NO 133
E 5125'-0" E 140 A&B
STABILIZER
NOTE: 1. THIS SKID IS
DRAWN SHOWING
UNION HDL
12"×14"×19" PUMP AND
IS SUBJECT TO CHECK
ON RECEIPT OF
CERTIFIED PRINTS
E-30 V-21 P-1 V-41
STABILIZER CRUDE
PRODUCT COOLER
STORAGE TANK
AFTER COOLER

Answers to Assignment Sheets

Assignment Sheet 3

Architect Scale			
3/8″ = 1′-0″ (Nearest 1″)	1/2″ = 1′-0″ (Nearest 1″)	1″ - 1′-0″ (Nearest 1/2″)	1 1/2″ = 1′-0″ (Nearest 1/4″)
1. 10′-4″	7′-9″	3′-10 1/2″	2′-7″
2. 8′-10″	6′-7″	3′-3 1/2″	2′-2 1/2″
3. 14′-4″	10′-9″	5′-4 1/2″	3′-7″
4. 1′-0″	0′-9″	0′-4 1/2″	0′-2 3/4″
5. 6′-5″	4′-9″	2′-5″	1′-7″
6. 11′-6″	8′-8″	4′-4″	2′-10 1/2″
7. 13′-3″	9′-11″	4′-11 1/2″	3′-3 3/4″
8. 3′-8″	2′-9″	1′-4 1/2″	0′-11″

Civil Engineer Scale (One Place)		
	1″ = 10′-0″ (Nearest 10′)	1″ = 20′-0″ (Nearest 5′)
1.	39′-0″	78′-0″
2.	33′-0″	65′-0″
3.	54′-0″	108′-0″
4.	4′-0″	7′-0″
5.	24′-0″	48′-0″
6.	43′-0″	86′-0″
7.	50′-0″	99′-0″
8.	14′-0″	27′-0″

Answers to Assignment Sheets

Assignment Sheet 4

1. 8.625″
2. 9.00″
3. 12.00″
4. 11.24″
5. 7.00″
6. 5.50″
7. 40.48 lbs
8. 330 lbs
9. Face to face
10. Bottom of pipe
11. Top of steel
12. Elevation
13. Short radius
14. Long radius
15. 2.44″
16. 6.00″
17. 2.12″
18. 4.19″
19. 4.50″
20. 2.00″
21. 9.12″
22. 45.63 lbs
23. 67.76 lbs
24. .688″
25. 1.56″
26. 30″
27. 18″

Assignment Sheet 5

1. 384.23 lbs
2. 21.124 lbs
3. 56.49 lbs
4. 139.11 lbs
5. 305.34 lbs
6. 20 3/16″
7. 17′-0 7/8″
8. 16′-10 7/8″
9. 18 lbs
10. 482.67 lbs
11. 9′-10 5/8″
12. 9″
13. 9′-3 5/8″
14. 11′-3 1/4″
15. 558.58 lbs
16. 18′-3 1/2″
17. 197.37 lbs
18. 271.87 lbs
19. 17′-7 3/4″
20. 11″
21. 4′-9″
22. 10′-1 3/8″
23. 2′-2 1/4″
24. 323.48 lbs
25. 398.48 lbs
26. 9″
27. 6′-3 5/8″
28. 8′-10 3/8″
29. 16 1/4″
30. 3′-9″
31. 253.54 lbs
32. 2′-1 19/32″
33. 21′-3 13/32″
34. 7° 30 MIN
35. 23′-8″
36. 80° 14 MIN

	Decimals of a foot	Feet and inches
37.	25.0563′	25′-0 43/64″
38.	15.7768′	15′-9 21/64″
39.	10.1183′	10′-1 3/8″
40.	16.5634′	16′-6 43/64″
41.	21.3125′	21′-3 3/4″

Calculate lengths B and C and Angle D

42. B = 12′-8 3/4″ (12.7292′) C = 14′-7 9/32″ (14.6068′) D = 48° 55 MIN
43. B = 22′-3 1/2″ (22.2917′) C = 27′-8 53/64″ (27.7355′) D = 51° 12 MIN
44. B = 33′-4″ (33.3333′) C = 26′-11 63/64″ (26.9989′) D = 39° 0 MIN

Introduction to Pipe Drafting With CAD
Unit 1

Answers to Written Test

1. a. 6 d. 5 g. 1
   b. 7 e. 2 h. 4
   c. 3 f. 8 i. 9

2. a. Center line
   b. Coordinate line
   c. Pipe line
   d. Match line
   e. Equipment line
   f. Instrument air line

3. a. Vertical
   b. Drafter
   c. Layer
   d. Isometric
   e. ⅛", minimum

4. a. 3 d. 1
   b. 4 e. 2
   c. 6 f. 5

5. a. Process flow planner
   b. Isometric piping
   c. Piping symbols
   d. Digitizer tablet overlay

6. a. 4 e. 1
   b. 5 f. 7
   c. 6 g. 2
   d. 3

7. a. 2
   b. 4
   c: 1
   d. 3

Introduction to Pipe Drafting With CAD
Unit 1

Written Test

Name ______________________________ Date _______________ Score ___________

1. Match the terms on the right with their correct definitions.

_____a. Systematic regulatory statements published for manufacturing control and public use

_____b. Tubular or cylindrical shapes used for transporting gases, liquid, or fine solids, or for structural support

_____c. Standardized fittings and valves manufactured by various companies; used to assemble a piping system

_____d. A drafting field dealing with the drawing of pipe, pipe components, pipe systems, equipment, and support structures

_____e. Large implements used in the operation of a plant

_____f. A line drawing which illustrates the arrangement and relationship of various pipe components

_____g. Specifications, test methods, definitions, classifications, publications, or a practice approved to regulate or control manufacturing

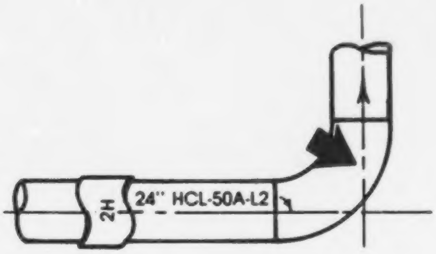
_____h. A device used to stop or control temperature, pressure, or flow rate

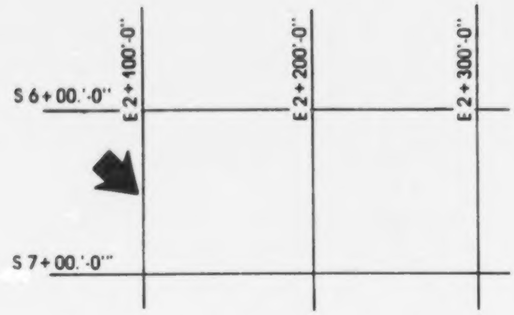
_____i. Container used in a piping system to hold, transform, or store a medium

1. Standard
2. Pipe equipment
3. Pipe components
4. Valve
5. Pipe drafting
6. Code
7. Pipe
8. Schematic
9. Vessel

Written Test

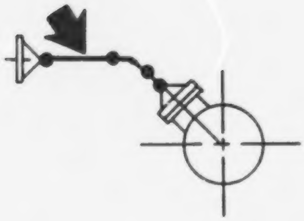
2. Identify the following types of lines.

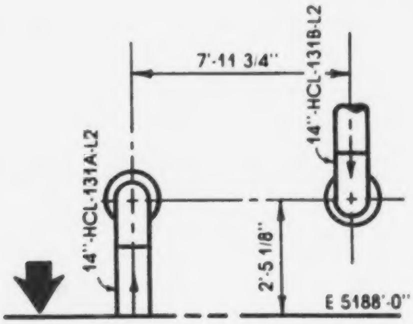

2H
24" HCL-50A-L2


S 6+00.'-0"
S 7+00.'-0'"
E 2+100'-0"
E 2+200'-0"
E 2+300'-0"

a. ______________

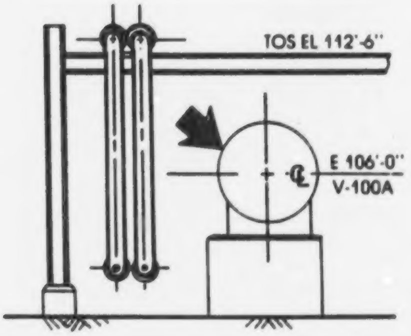
b. ______________

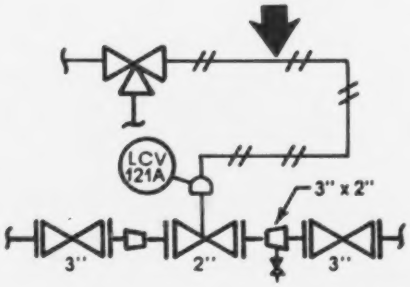



7'-11 3/4"
14"-HCL-131B-L2
14"-HCL-131A-L2
2'-5 1/8"
E 5188'-0"

c. ______________

d. ______________


TOS EL 112'-6"
E 106'-0"
V-100A


LCV
121A
3" x 2"
3"
2"
3"

e. ______________

f. ______________

Written Test

3. Complete statements concerning guidelines for lettering. Circle the material that best completes each of the following statements.

   a. Inclined or (**horizontal**) (**vertical**) lettering is used for the majority of drawings.

   b. The (**drafter**) (**engineer**) should match the size and style that is already used on the existing drawing when completing revisions.

   c. Many companies use a standard font, color, and (**layer**) (**linetype**) for equipment callouts, dimensions, and special notations.

   d. (**Isometric**) (**Inclined**) lettering is used in isometric drawings

   e. A minimum of (1/16") (1/8") lettering is used; special call-outs or titles use a (**minimum**) (**maximum**) of 1/4".

4. Match types of working drawings with their definitions. Place the number of the drawing in the blank beside the proper letter.

   ______a. A single line schematic that is drawn with no scale and includes the process flow, major equipment, instrumentation, major valves, and line sizes, pressures, and temperatures

   ______b. Drawing using information taken from site plan for purpose of drawing to a scale of 1"=20'-0" or 1"=10'-0" the location of buildings, equipment, and any physical information needed for design and construction of the piping system

   ______c. Views of piping from above, usually drawn to a scale of 3/8"=1'-0" that show line sizes, flow direction, coordinate locations, basic horizontal overall dimensions, match lines, equipment identifications, line specification numbers, and sectional-view references or material callouts

   1. Elevations
   2. Isometrics
   3. Mechanical flow diagram
   4. Plot plan and equipment layout
   5. Special fabrication details
   6. Piping plans

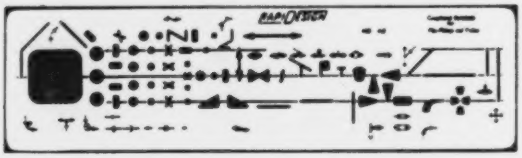
Written Test

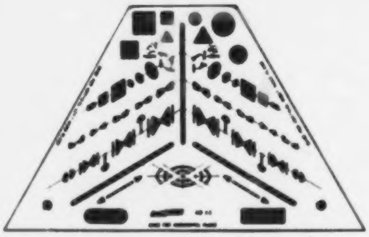
______d. Sectional views drawn to various scales that show line sizes, vertical dimensions, coordinate locations, equipment identifications, line specification numbers, and elevation dimensions

______e. Single or double line views not drawn to scale which show components, valves, fittings, dimensions, notes, and a bill of materials

______f. Views usually drawn to a scale of ½"=1'-0", 1"=1'-0", or 1½"=1'-0" which show details of special pipe fabrication, pipe supports, and/or structural piping

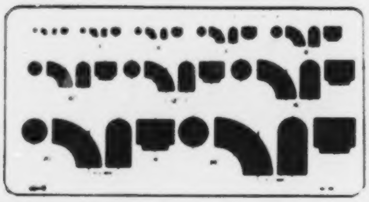
5. Identify the following types of drafting templates.

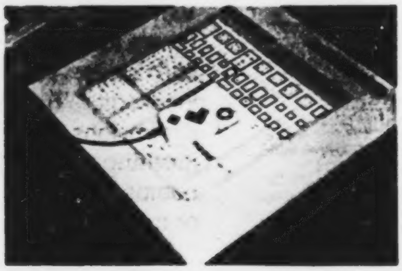




a. ________________________

b. ________________________





c. ________________________

d. ________________________

Written Test

6. Match piping standards on the right with their correct purposes.

______a. Organization which provides services to industry including the standardization of different codes, symbols, and abbreviations for piping, design, and dimensional properties

______b. A non-profit national technical society which promotes standardization of specifications, materials, fabrication methods, testing, and uses in the petroleum industry

______c. A non-profit national technical society which promotes engineering, standardizes different codes, and disseminates technical information of interest resulting in publication of these codes

______d. A non-profit national technical society which promotes the materials of engineering and standardizes specifications and methods of testing

______e. A non-profit national technical society which promotes water works piping or pipe fittings and standardizes specifications

1. AWWA
2. PFI
3. ASTM
4. ANSI
5. API
6. ASME
7. MSS

7. Match pipe drafting reference materials with their functions. Place the number of the material in the blank that describes its function.

______a. ANSI standards set proper symbols, linework, view arrangement, dimensioning standards, and other standard drafting practices

______b. Contain standards dealing with bolt hole patterns for different flange sizes, torquing procedures, temperature and coating procedures, weight and properties of pipe and pipe fittings, and formulas

1. Company standards
2. Standards
3. Manufacturers' catalogs
4. Industry publications

Written Test

______c. A set of standard drafting practices accumulated from various sources for continuity between design, engineering, and production departments

______d. An accumulated set of catalogs used to order products such as fittings, valves, and other standard pipe components; the publications usually have weight, dimensions, and properties of the products

***Permission to duplicate this test is granted.**

Introduction to Pipe Drafting With CAD
Unit 1

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Practice Vertical, Inclined, and CAD Lettering Rating _____

Comments: ______________________

Assignment Sheet 2—Practice Isometric Lettering Rating _____

Comments: ______________________

Assignment Sheet 3—Measure With Civil Engineer and Architect Scales Rating _____

Comments: ______________________

Assignment Sheet 4—Determine Piping Diameter, Weight, and Related Information Rating _____

Comments: ______________________

Assignment Sheet 5—Calculate Piping Math Problems Rating _____

Comments: ______________________

Assignment Sheet 6—Create a Subdirectory on a CAD system Rating _____

Comments: ______________________

Unit Evaluation Form

Assignment Sheet 7—Draw Piping Symbols on a CAD System

Rating ______

Comments: ____

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ____

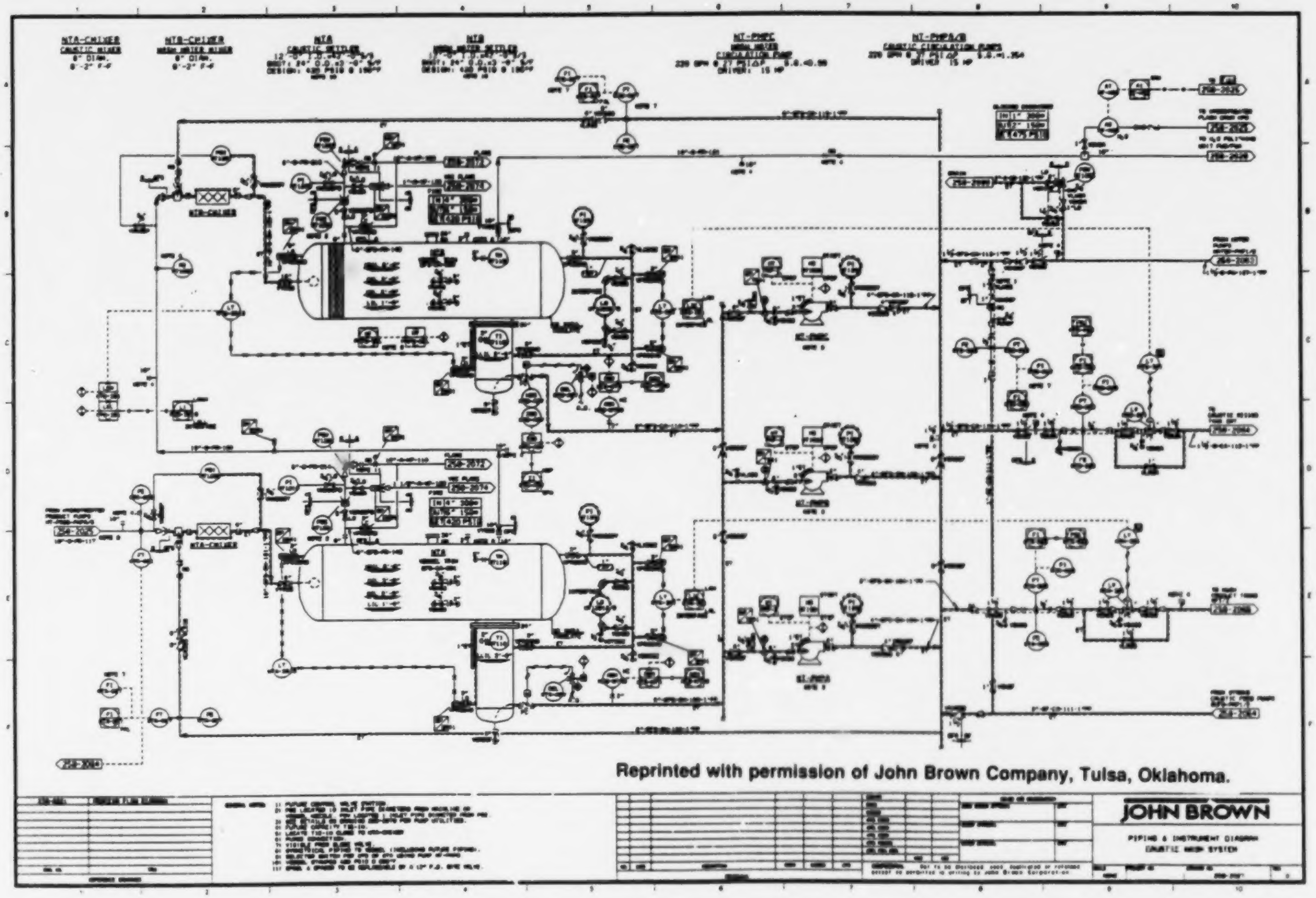
____

Teacher Signature ______________________________ Date ____________

Student Signature ______________________________ Date ____________

*Permission to duplicate this form is granted.**

Mechanical Flow Sheet


JOHN BROWN
PIPING & INSTRUMENT DIAGRAM
CAUSTIC WASH SYSTEM

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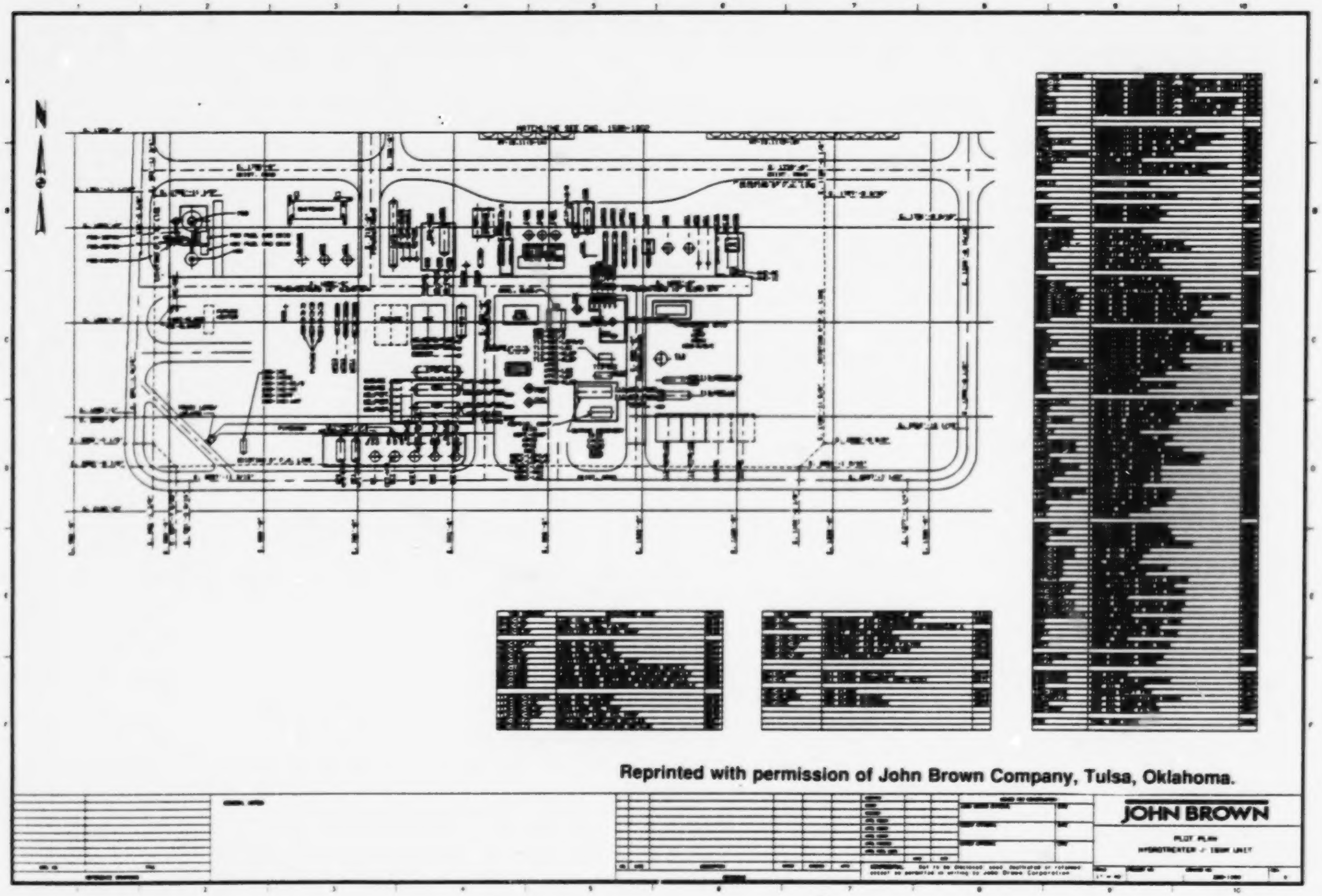
Plot Plan Initial Layout


N
JOHN BROWN
PLOT PLAN

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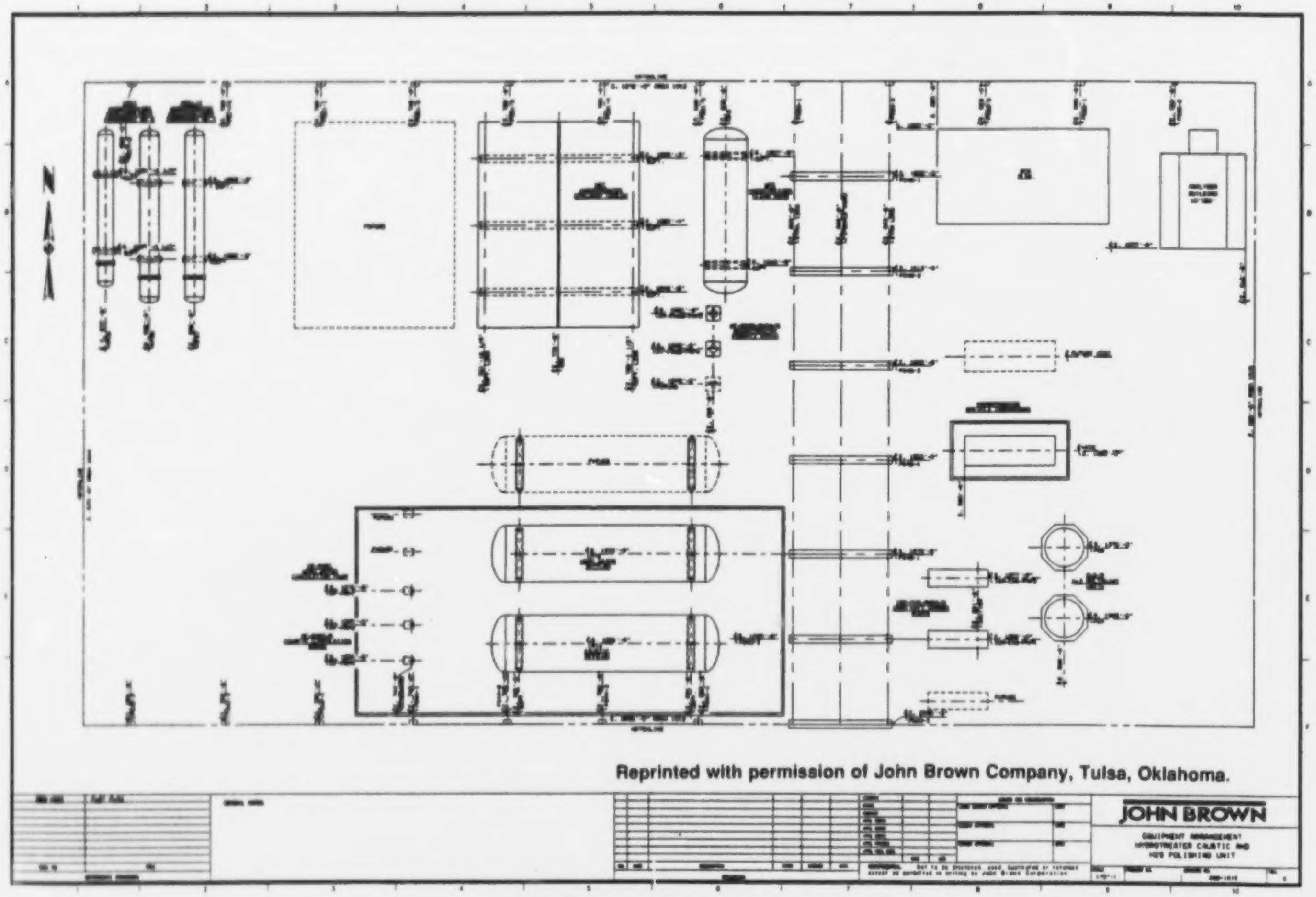
Plot Plan Equipment Layout



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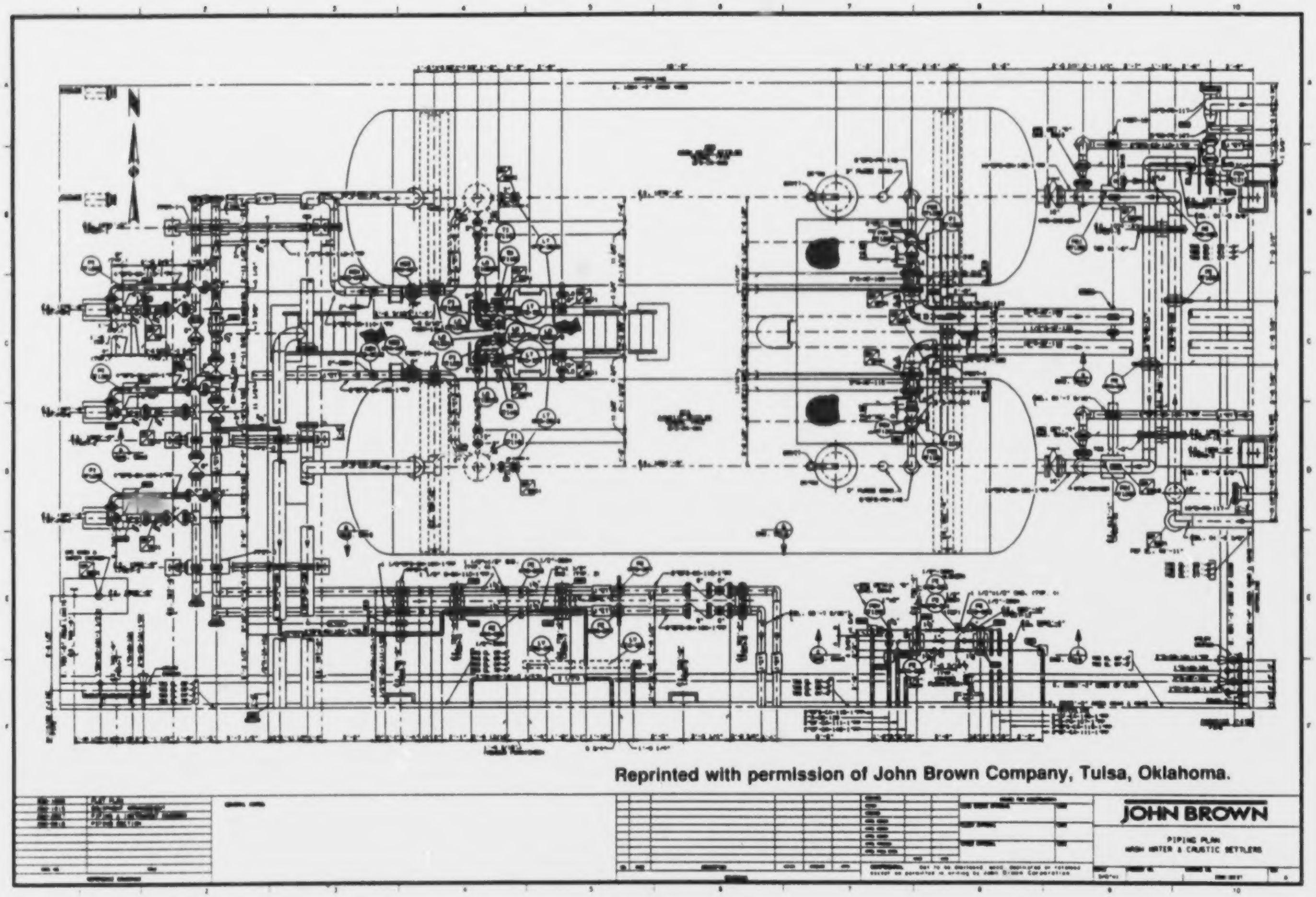
Piping Plan View


JOHN BROWN
PIPING PLAN
WASH WATER & CAUSTIC SETTLERS

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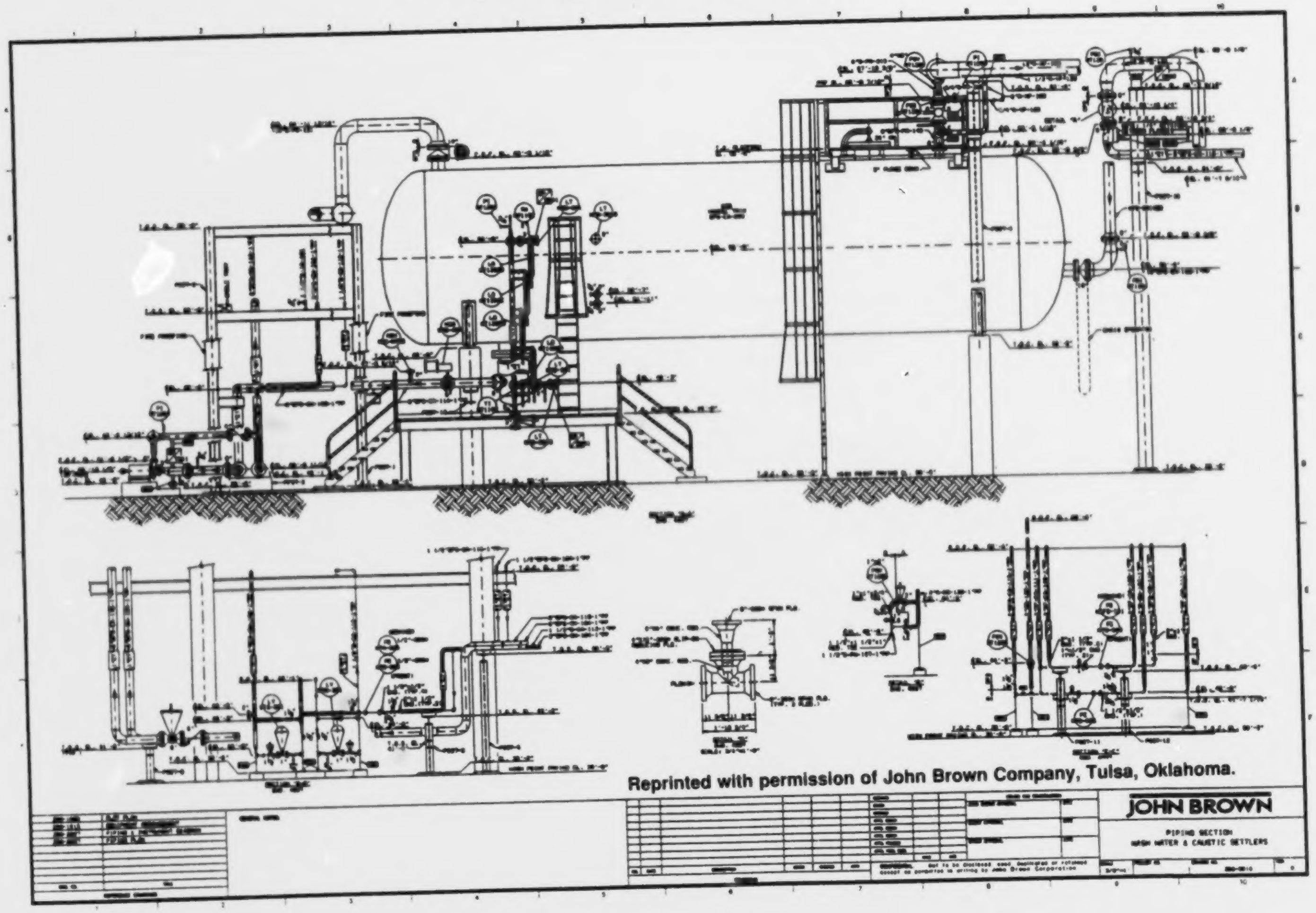
Piping Sections


JOHN BROWN
PIPING SECTION
WASH WATER & CAUSTIC SETTLERS

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Pipe Drafting With CAD, Unit 1
Teacher Page 29

TM 5

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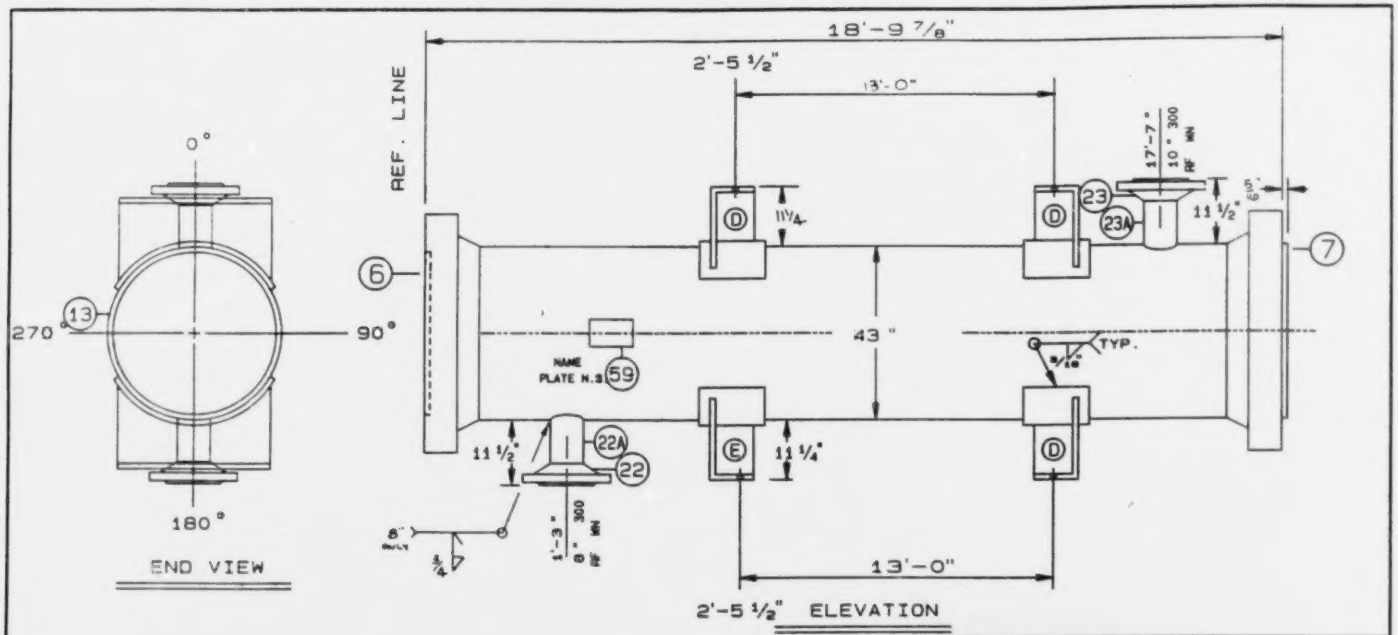
Special Fabrication Detail Drawings

Depropanizer Tray Layout

Pipe Drafting With CAD, Unit 1
Teacher Page 31



18'-9 7/8"
2'-5 1/2"
13'-0"
REF. LINE
0°
270°
90°
180°
END VIEW
13
6
7
D
E
23
23A
22
22A
59
NAME PLATE N.S
11 1/4
11 1/2"
43"
TYP.
17'-7"
10" 300 RF WN
6"
1'-3"
8" 300 RF WN
8"
3/4
13'-0"
2'-5 1/2" ELEVATION

NOTES ⑬ CYL 42" I.D. 1/2" THK. 213 1/8" LG.

1. SEE SHEET NO. 5 FOR BEVEL AND WELD DETAILS

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CUST-O-FAB, INC.
SAND SPRINGS, OKLAHOMA

CUSTOMER: SOHIO OIL COMPANY
P.O. NO: 428-0004-3770

SCALE: NONE
DATE: 10-04-1988
SHELL DETAILS
DRAWN BY: PETE
CHECKED BY: RON
TAB NO: E-10088
DWG. NO. 88-421P -4

TM 6

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Introduction to Pipe Drafting With CAD
Unit 1

Information Sheet

1. **Terms and definitions**

    a. **Code** — Systematic regulatory statements published for manufacturing control and public use

    b. **Pipe** — Tubular or cylindrical shapes used for transporting gases, liquid, or fine solids, or for structural support

    c. **Pipe components** — Standardized fittings and valves manufactured by various companies; used to assemble a piping system

    d. **Pipe drafting** — A drafting field dealing with the drawing of pipe, pipe components, pipe systems, equipment, and support structures

    e. **Pipe equipment** — Large implements used in the operation of a plant

    f. **Schematic** — A line drawing which illustrates the arrangement and relationship of various pipe components

    g. **Standard** — Specifications, test methods, definitions, classifications, publications, or a practice approved to regulate or control manufacturing

    h. **Valve** — A device used to stop or control temperature, pressure, or flow rate

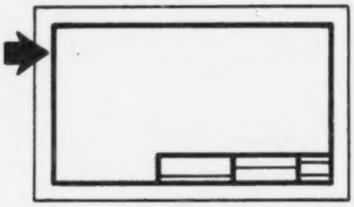
    i. **Vessel** — Container used in a piping system to hold, transform, or store a medium

2. **Types of lines in computer aided pipe drafting**

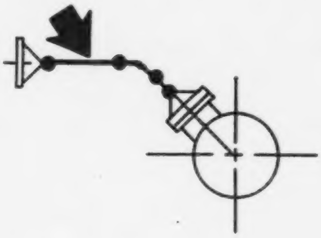
    Note: It is important to draw lines their proper thicknesses in order to show the relationship between piping, equipment, and notations. Since there are many lines on a pipe drawing, contrasts **MUST** be shown by emphasizing with color and thickness areas that need to stand out.

    a. **Lines that should be drawn thick.**

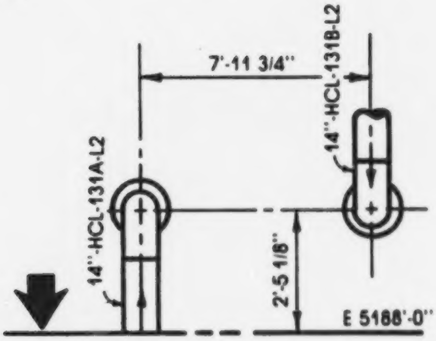
        (1) Border lines



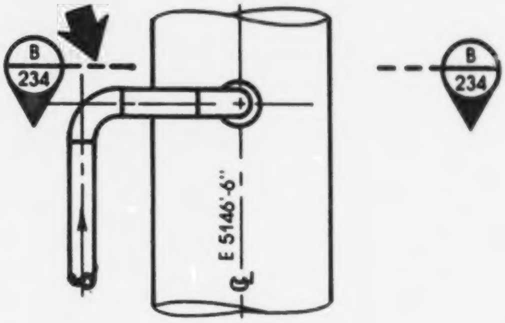
(2) Pipe lines



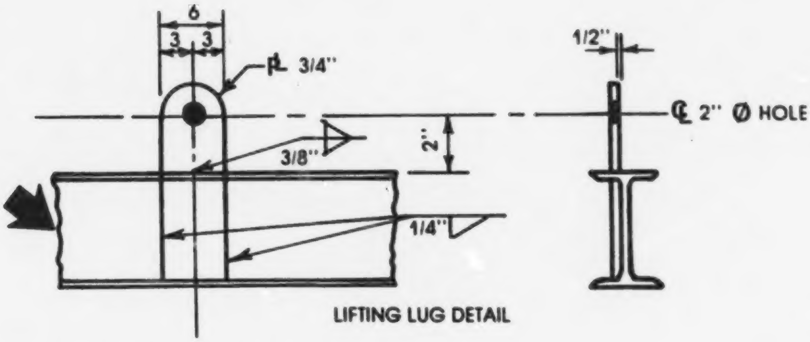
(3) Match and boundary lines


7'-11 3/4"
14"-HCL-131B-L2
14"-HCL-131A-L2
2'-5 1/8"
E 5188'-0"

(4) Cutting plane lines


B
234
B
234
E 5146'-6"
℄

(5) Break lines

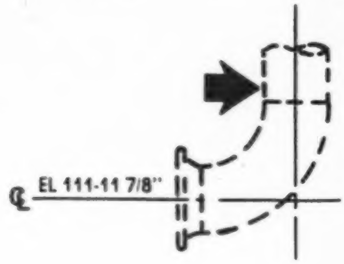

6
3
3
℄ 3/4"
3/8"
2"
1/4"
1/2"
℄ 2" Ø HOLE

LIFTING LUG DETAIL

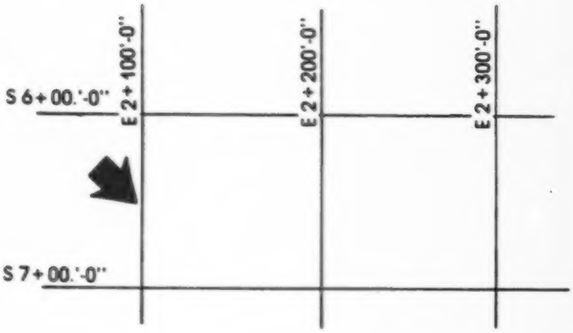
Information Sheet

b. **Lines that should be drawn thin and dark**

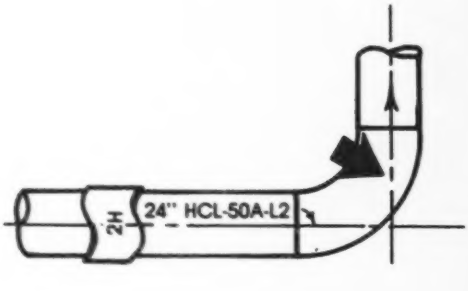
(1) Hidden lines—are used for existing equipment and under-ground lines.



(2) Coordinate lines

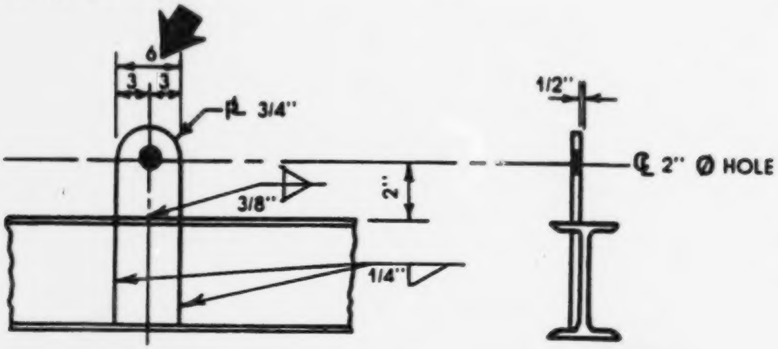

E 2+100'-0"
E 2+200'-0"
E 2+300'-0"
S 6+00.'-0"
S 7+00.'-0"

(3) Center lines

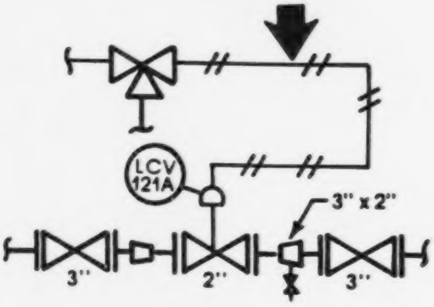

2H
24" HCL-50A-L2

Information Sheet

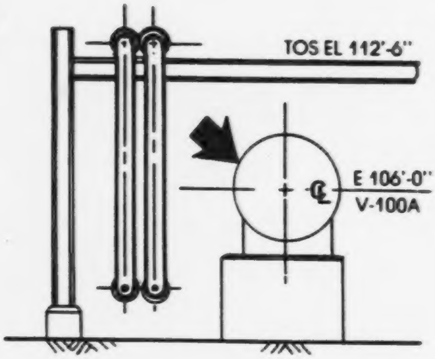
(4) Dimension lines


6
3
3
℄ 3/4"
1/2"
℄ 2" Ø HOLE
2"
3/8"
1/4"

(5) Instrument air lines


LCV
121A
3" x 2"
3"
2"
3"

(6) Equipment and structural lines


TOS EL 112'-6"
℄ E 106'-0"
V-100A

Information Sheet

3. Guidelines for lettering

Note: Review "Lettering," Unit VII of Basic Drafting.

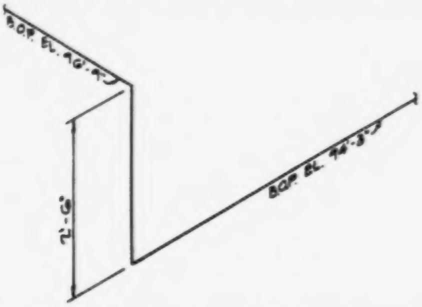
a. Inclined or vertical lettering is used for the majority of drawings.

b. The drafter should match the size and style that is already used on the existing drawing when completing revisions.

c. Many companies use a standard font, color, and layer for equipment callouts, dimensions, and special notations.

d. Isometric lettering is used in isometric drawings

Note: This should not be confused with inclined lettering which is slanted to the right. Isometric lettering must be done in the correct isometric plane.



e. A minimum of ⅛" lettering is used; special call-outs or titles use a minimum of ¼".

Note: This is important since many drawings are reproduced half-size or microfilmed.

4. **Types of working drawings and their definitions**

   Note: Diagrams listed in this objective are presented at other places in this unit. Your instructor will show transparency masters of some diagrams, and others will be found in student supplements.

   a. **Mechanical flow diagram** — A single line schematic that is drawn with no scale and includes the process flow, major equipment, instrumentation, major valves, and line sizes, pressures, and temperatures (TM1)

   b. **Plot plan and equipment layout** — Drawing using information taken from site plan for purpose of drawing to a scale of 1"=20'-0" or 1"=10'-0" the location of buildings, equipment, and any physical information needed for design and construction of the piping system (TM2, TM3)

   c. **Piping plans** — Views of piping from above, usually drawn to a scale of ⅜"=1'-0" that show line sizes, flow direction, coordinate locations, basic horizontal overall dimensions, match lines, equipment identifications, line specification numbers, and sectional-view references or material callouts

      Note: Pipe plans and elevations are often referred to as "P&Es." (TM4)

   d. **Elevations** — Sectional views drawn to various scales that show line sizes, vertical dimensions, coordinate locations, equipment identifications, line specification numbers, and elevation dimensions (TM5)

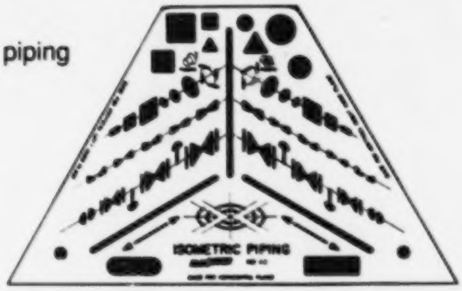
   e. **Isometrics** — Single or double line views not drawn to scale which show components, valves, fittings, dimensions, notes, and a bill of materials

   f. **Special fabrication details** — Views usually drawn to a scale of ½"=1'-0", 1"=1'-0", or 1½"=1'-0" which show details of special pipe fabrication, pipe supports, and/or structural piping (TM6)

5. **Common types of drafting templates**

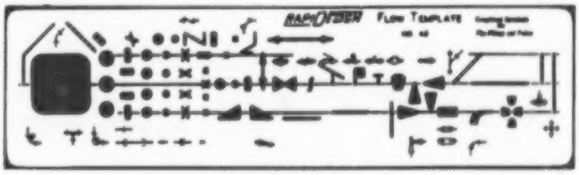
   a. Plastic templates designed for used in traditional drafting board envirohments include:

      (1) Isometric piping

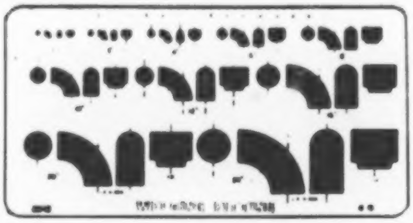


Information Sheet

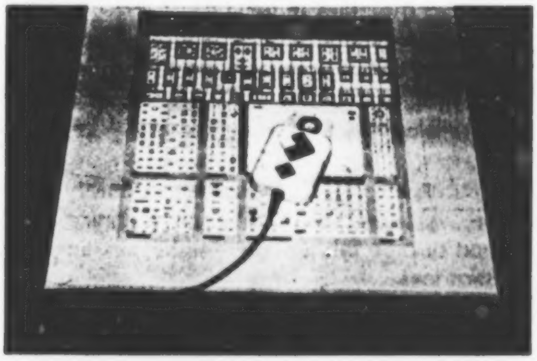
(2) Process flow planner



(3) Piping symbols



b. Digitizer tablet overlays are designed primarily to overlay in the Menu Area #1 of the standard AutoCAD overlay.



c. Digitizer tablet overlays may be developed by a third party or customized by a drafter.

Information Sheet

d. Third party packaged software programs are designed specifically to make pipe drafting the main function of the CAD program.

e. Third party programs usually integrate a custom digitizer overlay, custom icon pull-down menus, and autoslip routines that perform many standard functions for a pipe drafter.

f. Third party programs usually have to be modified to accomplish specific company needs.

6. **Piping standards and their purposes**

a. **ANSI (American National Standards Institute)** — Organization which provides services to industry including the standardization of different codes, symbols, and abbreviations for piping, design, and dimensional properties

b. **API (American Petroleum Institute)** — A non-profit national technical society which promotes standardization of specifications, materials, fabrication methods, testing, and uses in the petroleum industry

c. **ASME (American Society of Mechanical Engineers)** — A non-profit national technical society which promotes engineering, standardizes different codes, and disseminates technical information of interest resulting in publication of these codes

d. **ASTM (American Society for Testing and Materials)** — A non-profit national technical society which promotes the materials of engineering and standardizes specifications and methods of testing

e. **AWWA (American Water Works Association)** — A non-profit national technical society which promotes water works piping or pipe fittings and standardizes specifications

f. **MSS (Manufacturers Standardization Society of the Valve and Fitting Industry)** — A non-profit national technical society which promotes standardization of pipe fabrication, establishes limits of responsibility, and sets allowable tolerances

g. **PFI (Pipe Fabrication Institute)** — A non-profit national technical society which promotes the standardization of pipe fabrication, establishes limits of responsibility, and sets allowable tolerances

Information Sheet

7. **Pipe drafting reference materials and their functions**

   a. **Standards** — ANSI standards set proper symbols, linework, view arrangement, dimensioning standards, and other standard drafting practices

   b. **Industry Publications** — Contain standards dealing with bolt hole patterns for different flange sizes, torquing procedures, temperature and coating procedures, weight and properties of pipe and pipe fittings, and formulas

   c. **Company Standards** — A set of standard drafting practices accumulated from various sources for continuity between design, engineering, and production departments

   d. **Manufacturers' Catalogs** — An accumulated set of catalogs used to order products such as fittings, valves, and other standard pipe components; the publications usually have weight, dimensions, and properties of the products

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 1—Common Pipe Abbreviations

ACCUM	Accumulator
AI	All iron
AISC	American Institute of Steel Construction
AL	Aluminum
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASSY	Assembly
ASTM	American Society for Testing and Materials
AUX	Auxiliary
AWS	American Welding Society
AWWA	American Waterworks Association
B	Beveled
BB	Bolted bonnet
B&B	Bell and bell
BC	Bolt Circle
BD	Blowdown
BE	Beveled ends
BF	Bottom flat or Blind flange
BLDG	Building
B/M (BM)	Bill of material
BOC	Bottom of concrete
BOP	Bottom of pipe
BOS	Bottom of steel
BR	Bronze
BRS	Brass
B&S	Bell and spigot
BTM	Bottom
BW	Butt weld
°C	Degrees centigrade
CBD	Continuous blowdown
C TO C	Center to center
CD	Closed drain
CFM	Cubic feet per minute
CH-O	Chain-operated
CI	Cast iron
CL	Clearance
CL	Center line ℄
CO	Clean out
COL	Column
CONC	Concentric
COND	Condensate
CONN	Connection
CONT	Continuation
CORR	Corrosion
CPLG	Coupling
CS	Carbon steel or Cast steel
CSC	Car seal closed
CSO	Car seal open
CWP	Cold working pressure
DC	Drain connection
DD	Double disk
DF	Drain funnel
DI	Ductile iron
DIA	Diameter
DISCH	Discharge
E	East
EA	Each
EBD	Emergency blowdown
ECC	Eccentric
EL or ELEV	Elevation
ELB	Elbowlet
ELL	Elbow
EQUIP	Equipment
ESD	Emergency shutdown
EXCH	Exchanger
EXH	Exhaust
FAB	Fabricate
°F	Degrees Fahrenheit
FF	Full face or Flat face
FFD	Flat, faced, and drilled
FL	Floor
FLG	Flange
FOB	Flat on bottom
FPS	Feet per second
FS	Far side
FS	Forged steel
FSS	Forged stainless steel
FTG	Fitting
FW	Field weld
GAL	Gallon
GALV	Galvanized
GPM	Gallons per minute
GR	Grade
GRD	Ground
GU	Guide
HDR	Header
HGR	Hanger
HOR or HORIZ	Horizontal
IBBM	Iron body bronze mounted
IBD	Intermittent blowdown
ID	Inside diameter
INS	insulate
IPS	Iron pipe size

Student Supplement 1

ISO	Isometric
JT	Joint
LOC	Location
LR	Long radius
MATL	Material
MAX	Maximum
M&F	Male and female
MI	Malleable iron
MIN	Minimum
MISC	Miscellaneous
N	North
NC	Normally closed
Ni	Nickel
NIP	Nipple
NO	Normally opened
NOM	Nominal
NOZ	Nozzle
NPS	National pipe size
NPT	National pipe thread
NRS	Nonrising stem
NS	Near side
NTS	Not to scale
OD	Outside diameter
OS&Y	Outside screw and yoke
PFI	Pipe Fabrication Institute
PL	Plate
PS	Pipe support
PSI	Pounds per square inch
PSIA	Pounds per square inch absolute
PSIG	Pounds per square inch gage
PVC	Polyvinyl chloride
R	Radius
RED	Reducer
REF	Reference
REQD	Required
REV	Revision
RF	Raised face
RTJ	Ring-type joint
RPM	Revolutions per minute
RS	Rising stem
S	South
SC	Sample connection
SCFH	Standard cubic feet per hour
SCFM	Standard cubic feet per minute
SCH	Schedule
SCR	Screwed ends
SCRD	Screwed
SECT	Section
SMLS	Seamless
SNUB	Snubber
SO	Slip-On
SOL	Sockolet
SP	Steam pressure
SPEC	Specification
SQ	Square
SR	Short radius
SS	Stainless steel
STD	Standard
STL	Steel
SUCT	Suction
SUPT	Support
SW	Socket weld
SWG	Swage
SWP	Standard working pressure
T or THD	Threaded
TC	Test connection
T&C	Threaded and coupled
TE	Threaded end
TEF	Teflon
TEMP	Temperature
T&G	Tongue and groove
THRU	Through
TOC	Top of concrete
TOP	Top of pipe
TOS	Top of steel
TURB	Turbine
TYP	Typical
VERT	Vertical
W	West
W/	With
WB	Welded bonnet
WE	Welded end
WF	Welded flange
WN	Welded neck
WOG	Water, oil, and gas pressure
WP	Working pressure
WSP	Working steam pressure
WT	Weight
XS	Extra strong
XXS	Double extra strong

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 2—Decimal of a Foot for Inches and Fractions

FRACTIONS	INCHES											
	0	1	2	3	4	5	6	7	8	9	10	11
0	0	.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167
1/64	.0013	.0846	.1680	.2513	.3346	.4180	.5013	.5846	.6680	.7513	.8346	.9180
1/32	.0026	.0859	.1693	.2526	.3359	.4193	.5026	.5859	.6693	.7526	.8359	.9193
3/64	.0039	.0872	.1706	.2539	.3372	.4206	.5039	.5872	.6706	.7539	.8372	.9206
1/16	.0052	.0885	.1719	.2552	.3385	.4219	.5052	.5885	.6719	.7552	.8385	.9219
5/64	.0065	.0898	.1732	.2565	.3398	.4232	.5065	.5898	.6732	.7565	.8398	.9232
3/32	.0078	.0911	.1745	.2578	.3411	.4245	.5078	.5911	.6745	.7578	.8411	.9245
7/64	.0091	.0924	.1758	.2591	.3424	.4258	.5091	.5924	.6758	.7591	.8424	.9258
1/8	.0104	.0937	.1771	.2604	.3437	.4271	.5104	.5937	.6771	.7604	.8437	.9271
9/64	.0117	.0951	.1784	.2617	.3451	.4284	.5117	.5951	.6784	.7617	.8451	.9284
5/32	.0130	.0964	.1797	.2630	.3464	.4297	.5130	.5964	.6797	.7630	.8464	.9297
11/64	.0143	.0977	.1810	.2643	.3477	.4310	.5143	.5977	.6810	.7643	.8477	.9310
3/16	.0156	.0990	.1823	.2656	.3490	.4323	.5156	.5990	.6823	.7656	.8490	.9323
12/64	.0169	.1003	.1836	.2669	.3503	.4336	.5169	.6003	.6836	.7669	.8503	.9336
7/32	.0182	.1016	.1849	.2682	.3516	.4349	.5182	.6016	.6849	.7682	.8516	.9349
15/64	.0195	.1029	.1862	.2695	.3529	.4362	.5195	.6029	.6862	.7695	.8529	.9362
1/4	.0208	.1042	.1875	.2708	.3542	.4375	.5208	.6042	.6875	.7708	.8542	.9375
17/64	.0221	.1055	.1888	.2721	.3555	.4388	.5221	.6055	.6888	.7721	.8556	.9388
9/32	.0234	.1068	.1901	.2734	.3568	.4401	.5234	.6068	.6901	.7734	.8568	.9401
19/64	.0247	.1081	.1914	.2747	.3581	.4414	.5247	.6081	.6914	.7747	.8581	.9414
5/16	.0260	.1094	.1927	.2760	.3594	.4427	.5260	.6094	.6927	.7760	.8594	.9427
21/64	.0273	.1107	.1940	.2773	.3607	.4440	.5273	.6107	.6940	.7773	.8607	.9440
11/32	.0286	.1120	.1953	.2786	.3620	.4453	.5286	.6120	.6953	.7786	.8620	.9453
23/64	.0299	.1133	.1966	.2799	.3633	.4466	.5299	.6133	.6966	.7799	.8633	.9466
3/8	.0312	.1146	.1979	.2812	.3646	.4479	.5312	.6146	.6979	.7812	.8646	.9479
25/64	.0326	.1159	.1992	.2826	.3659	.4492	.5326	.6159	.6992	.7826	.8659	.9492
13/32	.0339	.1172	.2005	.2839	.3672	.4505	.5339	.6172	.7005	.7839	.8672	.9505
27/64	.0352	.1185	.2018	.2852	.3685	.4518	.5352	.6185	.7018	.7852	.8685	.9518
7/16	.0365	.1198	.2031	.2865	.3698	.4531	.5365	.6198	.7031	.7865	.8698	.9531
29/64	.0378	.1211	.2044	.2878	.3711	.4544	.5378	.6211	.7044	.7878	.8711	.9544
15/32	.0391	.1224	.2067	.2891	.3724	.4557	.5391	.6224	.7057	.7891	.8724	.9557
31/64	.0404	.1237	.2070	.2904	.3737	.4570	.5404	.6237	.7070	.7904	.8737	.9570
1/2	.0417	.1250	.2083	.2917	.3750	.4583	.5417	.6250	.7083	.7917	.8750	.9583

Student Supplement 2

FRACTIONS	INCHES											
	0	1	2	3	4	5	6	7	8	9	10	11
33/64	.0430	.1263	.2096	.2930	.3763	.4596	.5430	.6263	.7096	.7930	.8763	.9596
17/32	.0443	.1276	.2109	.2943	.3776	.4609	.5443	.6276	.7109	.7943	.8776	.9609
35/64	.0456	.1289	.2122	.2956	.3789	.4622	.5456	.6289	.7122	.7956	.8789	.9622
9/16	.0469	.1302	.2135	.2969	.3802	.4635	.5469	.6302	.7135	.7969	.8802	.9635
37/64	.0482	.1315	.2148	.2982	.3815	.4648	.5482	.6315	.7148	.7982	.8815	.9648
19/32	.0495	.1328	.2161	.2995	.3828	.4661	.5495	.6328	.7161	.7995	.8828	.9661
39/64	.0508	.1341	.2174	.3008	.3841	.4674	.5508	.6341	.7174	.8008	.8841	.9674
5/8	.0521	.1354	.2188	.3021	.3854	.4688	.5521	.6354	.7188	.8021	.8854	.9688
41/64	.0534	.1367	.2201	.3034	.3867	.4701	.5534	.6367	.7201	.8034	.8867	.9701
21/32	.0547	.1380	.2214	.3047	.3880	.4714	.5547	.6380	.7214	.8047	.8880	.9714
43/64	.0560	.1393	.2227	.3060	.3893	.4727	.5560	.6393	.7227	.8060	.8893	.9727
11/16	.0573	.1406	.2240	.3073	.3906	.4740	.5573	.6706	.7240	.8073	.8906	.9740
45/64	.0586	.1419	.2253	.3086	.3919	.4753	.5586	.6419	.7253	.8086	.8919	.9753
23/32	.0599	.1432	.2266	.3099	.3932	.4766	.5599	.6432	.7266	.8099	.8932	.9766
47/64	.0612	.1445	.2279	.3112	.3945	.4779	.5612	.6445	.7276	.8112	.8945	.9779
3/4	.0625	.1458	.2292	.3125	.3958	.4792	.5625	.6458	.7292	.8125	.8958	.9792
43/64	.0638	.1471	.2305	.3138	.3971	.4805	.5638	.6471	.7305	.8138	.8971	.9805
25/32	.6051	.1484	.2318	.3151	.3984	.4818	.5651	.6484	.7318	.8151	.8984	.9818
51/64	.0664	.1497	.2331	.3164	.3997	.4831	.5664	.6497	.7331	.8164	.8997	.9831
13/16	.0677	.1510	.2344	.3177	.4010	.4844	.5677	.6510	.7344	.8177	.9010	.9844
53/64	.0690	.1523	.2357	.3190	.4023	.4857	.5690	.6523	.7357	.8190	.9023	.9857
27/32	.0703	.1536	.2370	.3203	.4036	.4870	.5703	.6536	.7370	.8203	.9036	.9870
55/64	.0716	.1549	.2383	.3216	.4049	.4883	.5716	.6549	.7383	.8216	.9049	.9883
7/8	.0729	.1562	.2396	.3229	.4062	.4896	.5729	.6562	.7396	.8229	.9062	.9896
57/64	.0742	.1576	.2409	.3242	.4076	.4909	.5742	.6576	.7409	.8242	.9076	.9909
29/32	.0755	.1589	.2422	.3255	.4089	.4922	.5755	.6589	.7422	.8255	.9089	.9922
59/64	.0768	.1602	.2435	.3268	.4102	.4935	.5768	.6602	.7435	.8268	.9102	.9935
15/16	.0781	.1615	.2448	.3281	.4115	.4948	.5781	.6615	.7448	.8281	.9115	.9948
61/64	.0794	.1628	.2461	.3294	.4128	.4961	.5794	.6628	.7461	.8294	.9128	.9961
31/32	.0807	.1641	.2474	.3307	.4141	.4974	.5807	.6641	.7474	.8307	.9141	.9987
63/64	.0820	.1654	.2487	.3320	.4154	.4987	.5820	.6654	.7487	.8320	.9154	.9987

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 3—Pipe Data
Carbon and Alloy Steel—Stainless Steel

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Nominal Pipe Size Inches	Outside Diam. Inches	Identification			Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal Square Inches	Weight Pipe Pounds per foot
		Steel		Stainless Steel Sched. No.				
		Iron Pipe Size	Sched. No.					
1/8	0.405	...	...	10S	.049	.307	.0548	.19
		STD	40	40S	.068	.269	.0720	.24
		XS	80	80S	.095	.215	.0925	.31
1/4	0.540	...	...	10S	.065	.410	.0970	.33
		STD	40	40S	.088	.364	.1250	.42
		XS	80	80S	.119	.302	.1574	.54
3/8	0.675	...	...	10S	.065	.545	.1246	.42
		STD	40	40S	.091	.493	.1670	.57
		XS	80	80S	.126	.423	.2173	.74
1/2	0.840	...	...	5S	.065	.710	.1583	.54
		...	...	10S	.083	.674	.1974	.67
		STD	40	40S	.109	.622	.2503	.85
		XS	80	80S	.147	.546	.3200	1.09
		...	160	...	.187	.466	.3836	1.31
		XXS	...	...	.294	.252	.5043	1.71
3/4	1.050	...	...	5S	.065	.920	.2011	.69
		...	...	10S	.083	.884	.2521	.86
		STD	40	40S	.113	.824	.3326	1.13
		XS	80	80S	.154	.742	.4335	1.47
		...	160	...	.219	.612	.5698	1.94
		XXS	...	...	.308	.434	.7180	2.44
1	1.315	...	...	5S	.065	1.185	.2553	.87
		...	...	10S	.109	1.097	.4130	1.40
		STD	40	40S	.133	1.049	.4939	1.68
		XS	80	80S	.179	.957	.6388	2.17
		...	160	...	.250	.815	.8365	2.84
		XXS	...	...	.358	.599	1.0760	3.66
1¼	1.660	...	...	5S	.065	1.530	.3257	1.11
		...	...	10S	.109	1.442	.4717	1.81
		STD	40	40S	.140	1.380	.6685	2.27
		XS	80	80S	.191	1.278	.8815	3.00
		...	160	...	.250	1.160	1.1070	3.76
		XXS	...	...	.382	.896	1.534	5.21
1½	1.900	...	...	5S	.065	1.770	.3747	1.28
		...	...	10S	.109	1.682	.6133	2.09
		STD	40	40S	.145	1.610	.7995	2.72
		XS	80	80S	.200	1.500	1.068	3.63
		...	160	...	.281	1.338	1.429	4.86
		XXS	...	...	.400	1.100	1.885	6.41

Identification, wall thickness and weights are extracted from ANSI B36.10 and B36.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe respectively.

Student Supplement 3

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Nominal Pipe Size Inches	Outside Diam. Inches	Identification			Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal Square Inches	Weight Pipe Pounds per foot
		Steel		Stainless Steel Sched. No.				
		Iron Pipe Size	Sched. No.					
2	2.375	...	...	5S	.065	2.245	.4717	1.61
		...	...	10S	.109	2.157	.7760	2.64
		STD	40	40S	.154	2.067	1.075	3.65
		XS	80	80S	.218	1.939	1.477	5.02
		...	160	...	.344	1.687	2.190	7.46
		XXS	...	...	.436	1.503	2.656	9.03
2½	2.875	...	...	5S	.083	2.709	.7280	2.48
		...	...	10S	.120	2.635	1.039	3.53
		STD	40	40S	.203	2.469	1.704	5.79
		XS	80	80S	.276	2.323	2.254	7.66
		...	160	...	.375	2.125	2.945	10.01
		XXS	...	...	.552	1.771	4.028	13.69
3	3.500	...	...	5S	.083	3.334	.8910	3.03
		...	...	10S	.120	3.260	1.274	4.33
		STD	40	40S	.216	3.068	2.228	7.58
		XS	80	80S	.300	2.900	3.016	10.25
		...	160	...	.438	2.624	4.205	14.32
		XXS	...	...	.600	2.300	5.466	18.58
3½	4.000	...	...	5S	.083	3.834	1.021	3.48
		...	...	10S	.120	3.760	1.463	4.97
		STD	40	40S	.226	3.548	2.680	9.11
		XS	80	80S	.318	3.364	3.678	12.50
4	4.500	...	...	5S	.083	4.334	1.152	3.92
		...	...	10S	.120	4.260	1.651	5.61
		STD	40	40S	.237	4.026	3.174	10.79
		XS	80	80S	.337	3.826	4.407	14.98
		...	120	...	.438	3.624	5.595	19.00
		...	160	...	.531	3.438	6.621	22.51
		XXS	...	...	.674	3.152	8.101	27.54
5	5.563	...	...	5S	.109	5.345	1.868	6.36
		...	...	10S	.134	5.295	2.285	7.77
		STD	40	40S	.258	5.047	4.300	14.62
		XS	80	80S	.375	4.813	6.112	20.78
		...	120	...	.500	4.563	7.953	27.04
		...	160	...	.625	4.313	9.696	32.96
		XXS	...	...	.750	4.063	11.340	38.55
6	6.625	...	...	5S	.109	6.407	2.231	7.60
		...	...	10S	.134	6.357	2.733	9.29
		STD	40	40S	.280	6.065	5.581	18.97
		XS	80	80S	.432	5.761	8.405	28.57
		...	120	...	.562	5.501	10.70	36.39
		...	160	...	.719	5.187	13.32	45.35
		XXS	...	...	.864	4.897	15.64	53.16

Transverse internal area values listed in "square feet" also represent volume in cubic feet per foot of pipe length.

Student Supplement 3

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Nominal Pipe Size Inches	Outside Diam. Inches	Identification			Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal Square Inches	Weight Pipe Pounds per foot
		Steel		Stainless Steel Sched. No.				
		Iron Pipe Size	Sched. No.					
8	8.625	...	...	5S	.109	8.407	2.916	9.93
		...	...	10S	.148	8.329	3.941	13.40
		...	20	...	.250	8.125	6.57	22.36
		...	30	...	.277	8.071	7.26	24.70
		STD	40	40S	.322	7.981	8.40	28.55
		...	60	...	.406	7.813	10.48	35.64
		XS	80	80S	.500	7.625	12.76	43.39
		...	100	...	.594	7.437	14.96	50.95
		...	120	...	.719	7.187	17.84	60.71
		...	140	...	.812	7.001	19.93	67.76
		XXS	...	...	.875	6.875	21.30	72.42
		...	160	...	.906	6.813	21.97	74.69
10	10.750	...	...	5S	.134	10.482	4.36	15.19
		...	...	10S	.165	10.420	5.49	18.65
		...	20	...	.250	10.250	8.24	28.04
		...	30	...	.307	10.136	10.07	34.24
		STD	40	40S	.365	10.020	11.90	40.48
		XS	60	80S	.500	9.750	16.10	54.74
		...	80	...	.594	9.562	18.92	64.43
		...	100	...	.719	9.312	22.63	77.03
		...	120	...	.844	9.062	26.24	89.29
		XXS	140	...	1.000	8.750	30.63	104.13
		...	160	...	1.125	8.500	34.02	115.64
12	12.75	...	...	5S	.156	12.438	6.17	20.98
		...	...	10S	.180	12.390	7.11	24.17
		...	20	...	.250	12.250	9.82	33.38
		...	30	...	.330	12.090	12.87	43.77
		STD	...	40S	.375	12.000	14.58	49.56
		...	40	...	.406	11.938	15.77	53.52
		XS	...	80S	.500	11.750	19.24	65.42
		...	60	...	.562	11.626	21.52	73.15
		...	80	...	.688	11.374	26.03	88.63
		...	100	...	.844	11.062	1.53	107.32
		XXS	120	...	1.000	10.750	36.91	125.49
		...	140	...	1.125	10.500	41.08	139.67
		...	160	...	1.312	10.126	47.14	160.27

Identification, wall thickness and weights are extracted from ANSI B36.10 and B36.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe respectively.

Student Supplement 3

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Nominal Pipe Size Inches	Outside Diam. Inches	Identification			Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal Square Inches	Weight Pipe Pounds per foot
		Steel		Stainless Steel Sched. No.				
		Iron Pipe Size	Sched. No.					
14	14.00	...	...	5S	.156	13.688	6.78	23.07
		...	...	10S	.188	13.624	8.16	27.73
		...	10	...	.250	13.500	10.80	36.71
		...	20	...	.312	13.376	13.42	45.61
		STD	30	...	.375	13.250	16.05	54.57
		...	40	...	.438	13.124	18.66	63.44
		XS	...	...	.500	13.000	21.21	72.09
		...	60	...	.594	12.812	24.98	85.05
		...	80	...	.750	12.500	31.22	106.13
		...	100	...	.938	12.124	38.45	130.85
		...	120	...	1.094	11.812	44.32	150.79
		...	140	...	1.250	11.500	50.07	170.28
		...	160	...	1.406	11.188	55.63	189.11
16	16.00	...	...	5S	.165	15.670	8.21	27.90
		...	...	10S	.188	15.624	9.34	31.75
		...	10	...	.250	15.500	12.37	42.05
		...	20	...	.312	15.376	15.38	52.27
		STD	30	...	.375	15.250	18.41	62.58
		XS	40	...	.500	15.000	24.35	82.77
		...	60	...	.656	14.688	31.62	107.50
		...	80	...	.844	14.312	40.14	136.61
		...	100	...	1.031	13.938	48.48	164.82
		...	120	...	1.219	13.562	56.56	192.43
		...	140	...	1.438	13.124	65.78	223.64
		...	160	...	1.594	12.812	72.10	245.25
18	18.00	...	...	5S	.165	17.670	9.25	31.43
		...	...	10S	.188	17.624	10.52	35.76
		...	10	...	.250	17.500	13.94	47.39
		...	20	...	.312	17.376	17.34	58.94
		STD	...	...	.375	17.250	20.76	70.59
		...	30	...	.438	17.124	24.17	82.15
		XS	...	...	.500	17.000	27.49	93.45
		...	40	...	.562	16.876	30.79	104.67
		...	60	...	.750	16.500	40.64	138.17
		...	80	...	.938	16.124	50.23	170.92
		...	100	...	1.156	15.688	61.17	207.96
		...	120	...	1.375	15.250	71.81	244.14
		...	140	...	1.562	14.876	80.66	274.22
		...	160	...	1.781	14.438	90.75	308.50

Identification, wall thickness and weights are extracted from ANSI B36.10 and B36.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe respectively.

Student Supplement 3

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Nominal Pipe Size Inches	Outside Diam. Inches	Identification			Wall Thickness (t) Inches	Inside Diameter (d) Inches	Area of Metal Square Inches	Weight Pipe Pounds per foot
		Steel		Stainless Steel Sched. No.				
		Iron Pipe Size	Sched. No.					
20	20.00	...	...	5S	.188	19.624	11.70	39.78
		...	...	10S	.218	19.564	13.55	46.06
		...	10	...	.250	19.500	15.51	52.73
		STD	20	...	.375	19.250	23.12	78.60
		XS	30	...	.500	19.000	30.63	104.13
		...	40	...	.594	18.812	36.15	123.11
		...	60	...	.812	18.376	48.95	166.40
		...	80	...	1.031	17.938	61.44	208.87
		...	100	...	1.281	17.438	75.33	256.10
		...	120	...	1.500	17.000	87.18	296.37
		...	140	...	1.750	16.500	100.33	341.09
		...	160	...	1.969	16.062	111.49	379.17
22	22.00	...	...	5S	.188	21.624	12.88	43.80
		...	...	10S	.218	21.564	14.92	50.71
		...	10	...	.250	21.500	17.08	58.07
		STD	20	...	.375	21.250	25.48	86.61
		XS	30	...	.500	21.000	33.77	114.81
		...	60	...	.875	20.250	58.07	197.41
		...	80	...	1.125	19.75	73.78	250.81
		...	100	...	1.375	19.25	89.09	302.88
		...	120	...	1.625	18.75	104.02	353.61
		...	140	...	1.875	18.25	118.55	403.00
		...	160	...	2.125	17.75	132.68	451.06
24	24.00	...	...	5S	.218	23.564	16.29	55.37
		...	10	10S	.250	23.500	18.65	63.41
		STD	20	...	.375	23.250	27.83	94.62
		XS	...	...	.500	23.000	36.91	125.49
		...	30	...	.562	22.876	41.39	140.68
		...	40	...	.688	22.624	50.31	171.29
		...	60	...	.969	22.062	70.04	238.35
		...	80	...	1.219	21.562	87.17	296.58
		...	100	...	1.531	20.938	108.07	367.39
		...	120	...	1.812	20.376	126.31	429.39
		...	140	...	2.062	19.876	142.11	483.12
		...	160	...	2.344	19.312	159.41	542.13

Identification, wall thickness and weights are extracted from ANSI B36.10 and B36.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe respectively.

Student Supplement 3
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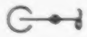
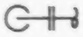
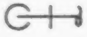
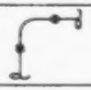
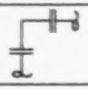
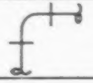
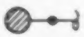
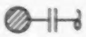
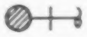
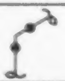
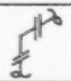
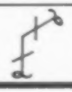
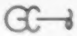
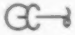
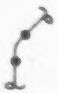
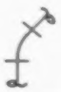
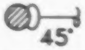
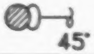
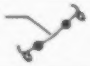
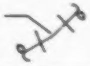
Nominal Pipe Size	Outside Diam.	Identification			Wall Thickness (t)	Inside Diameter (d)	Area of Metal	Weight Pipe
		Steel		Stainless Steel Sched. No.				
Inches	Inches	Iron Pipe Size	Sched. No.		Inches	Inches	Square Inches	Pounds per foot
26	26.00	...	10	...	.312	25.376	25.18	85.60
		STD	...	...	.375	25.250	30.19	102.63
		XS	20	...	.500	25.000	40.06	136.17
28	28.00	...	10	...	.312	27.376	27.14	92.26
		STD	...	...	.375	27.250	32.54	110.64
		XS	20	...	.500	27.000	43.20	146.85
		...	30	...	.625	26.750	53.75	182.73
30	30.00	...	...	5S	.250	29.500	23.37	79.43
		...	10	10S	.312	29.376	29.10	98.93
		STD	...	...	.375	29.250	34.90	118.65
		XS	20	...	.500	29.000	46.34	157.53
		...	30	...	.625	28.750	57.68	196.08
32	32.00	...	10	...	.312	31.376	31.06	105.59
		STD	...	...	.375	31.250	37.26	126.66
		XS	20	...	.500	31.000	49.48	168.21
		...	30	...	.625	30.750	61.60	209.43
		...	40	...	.688	30.624	67.68	230.08
34	34.00	...	10	...	.344	33.312	36.37	123.65
		STD	...	...	.375	33.250	39.61	134.67
		XS	20	...	.500	33.000	52.62	178.89
		...	30	...	.625	32.750	65.53	222.78
		...	40	...	.688	32.624	72.00	244.77
36	36.00	...	10	...	.312	35.376	34.98	118.92
		STD	...	...	.375	35.250	41.97	142.68
		XS	20	...	.500	35.000	55.76	189.57
		...	30	...	.625	34.750	69.46	236.13
		...	40	...	.750	34.500	83.06	282.35

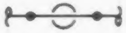
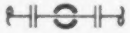
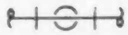
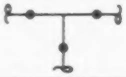
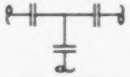
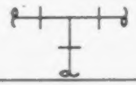
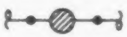
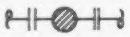
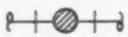
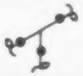
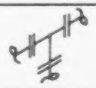
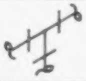
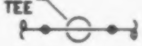
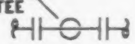
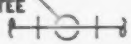
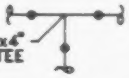
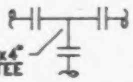
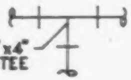
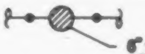
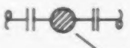
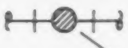
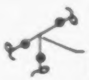
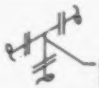
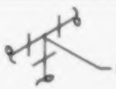
Identification, wall thickness and weights are extracted from ANSI B36.10 and B36.19. The notations STD, XS, and XXS indicate Standard, Extra Strong, and Double Extra Strong pipe respectively.

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 4—Piping Symbols
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
ELBOW 90° NOTE: IF SHORT RADIUS IS USED ADD CALLOUT S.R.	PLAN			
	ELEVATION			
	BOTTOM			
	ISOMETRIC			
ELBOW 45°	PLAN	45° 	NOT A STANDARD	45° 
	ELEVATION			
	BOTTOM	 45°		 45°
	ISOMETRIC	45° ELL 		45° ELL 

Student Supplement 4
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
TEE	PLAN			
	ELEVATION			
	BOTTOM			
	ISOMETRIC			
REDUCING TEE	PLAN	6"x6"x4" RED. TEE 	6"x6"x4" RED. TEE 	6"x6"x4" RED. TEE 
	ELEVATION	 6"x6"x4" RED. TEE	 6"x6"x4" RED. TEE	 6"x6"x4" RED. TEE
	BOTTOM	 6"x6"x4" RED. TEE	 6"x6"x4" RED. TEE	 6"x6"x4" RED. TEE
	ISOMETRIC	 6"x6"x4" RED. TEE	 6"x6"x4" RED. TEE	 6"x6"x4" RED. TEE

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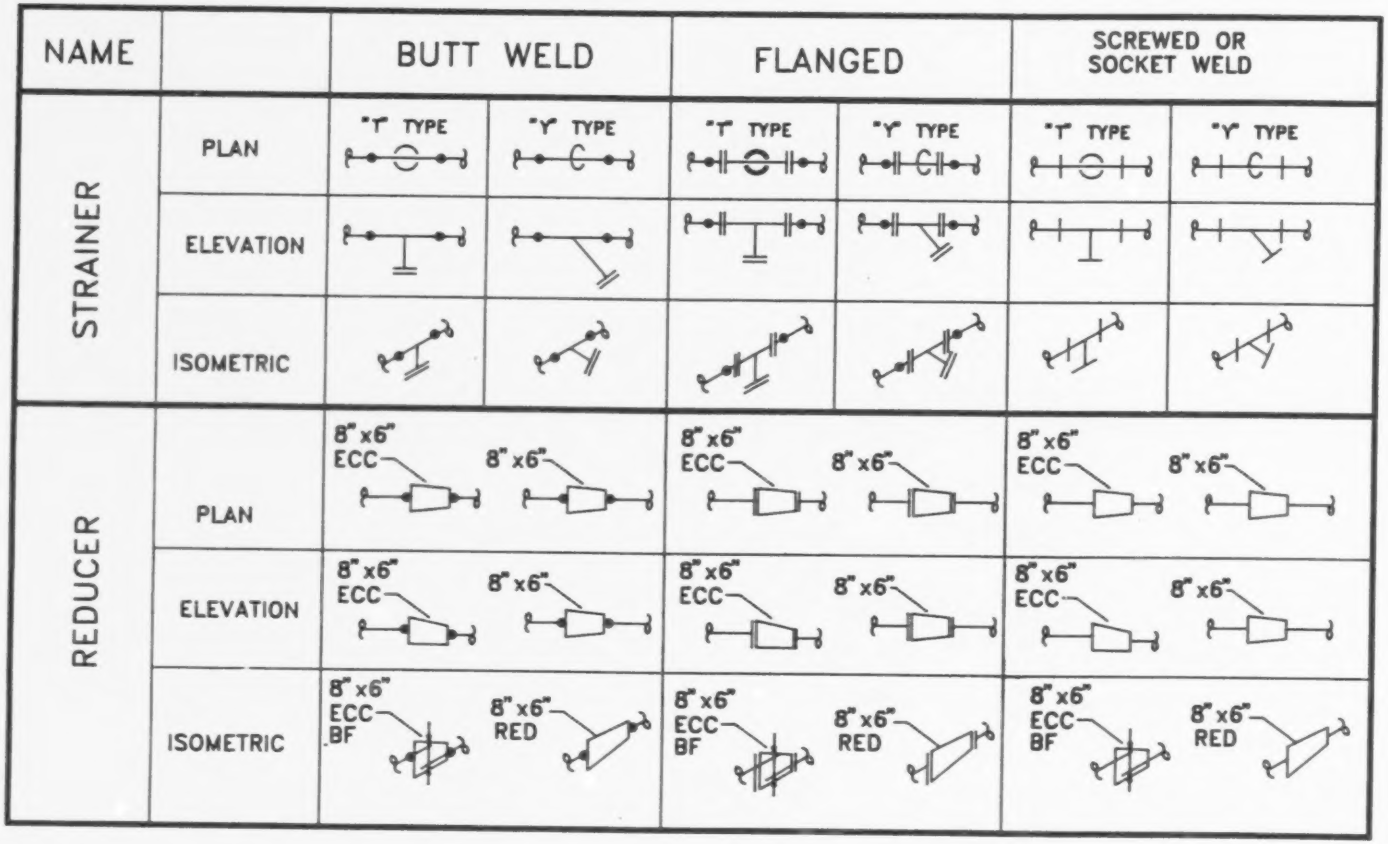
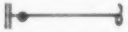
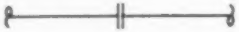
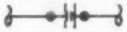
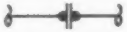
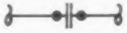
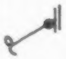
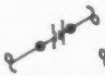
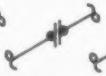
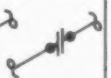
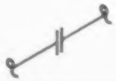
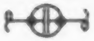
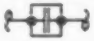
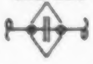
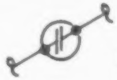
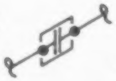
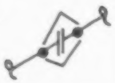
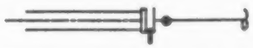
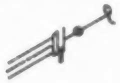
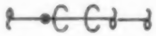
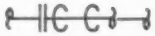
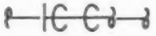
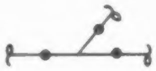
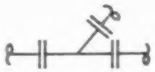
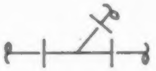
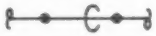
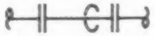
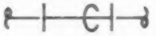
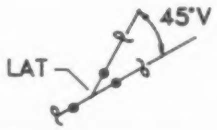
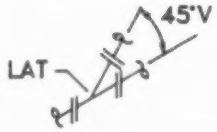
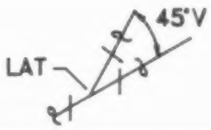

NAME
BUTT WELD
FLANGED
SCREWED OR SOCKET WELD
STRAINER
PLAN
ELEVATION
ISOMETRIC
"T" TYPE
"Y" TYPE
REDUCER
8"x6" ECC
8"x6"
8"x6" ECC BF
8"x6" RED

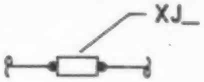
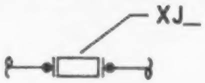
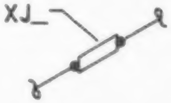
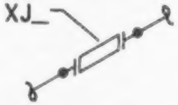
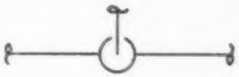
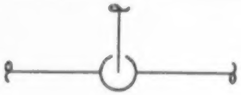
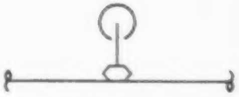
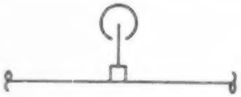
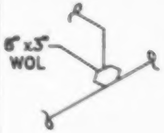
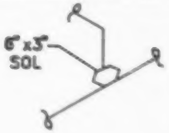
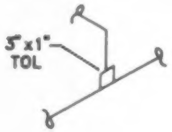
Student Supplement 4
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
FLANGES	BLIND			PLAN & ELEV VIEW 
	LAP JOINT			
	SLIP-ON			
	WELD NECK			
	ISOMETRIC	 BLIND  LAP JOINT  SLIP-ON  WELD NECK		
MECHANICAL PIPE JOINERS	PLAN & ELEVATION		VIC & DRESSER  TRI-CLAMP  GREYLOC 	
	ISOMETRIC		  	

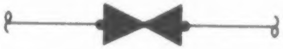
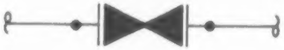
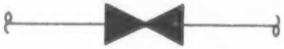
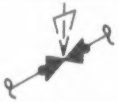
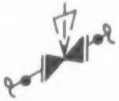
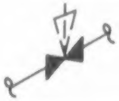
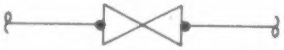
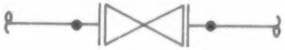
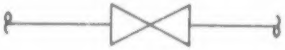
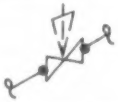
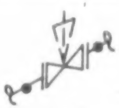
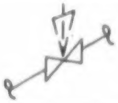
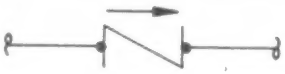
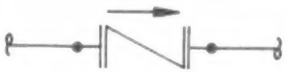
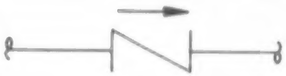
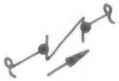
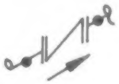
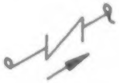
Student Supplement 4
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
GASKET	PLAN& ELEVATION			
	ISOMETRIC			
LATERAL (LAT)	PLAN			
	ELEVATION			
	BOTTOM			
	ISOMETRIC			

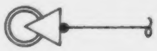
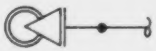
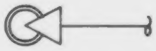
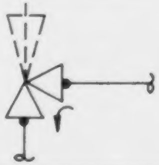
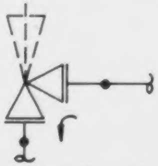
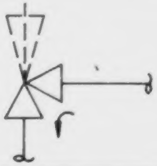
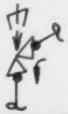
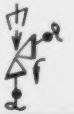
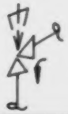
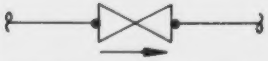
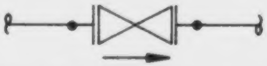
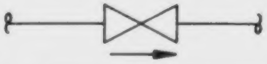
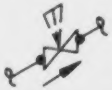
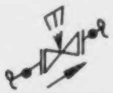
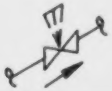
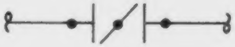
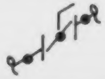
Student Supplement 4
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
EXPANSION JOINT	PLAN & ELEVATION			
	ISOMETRIC			
OLET	PLAN			
	ELEVATION			
TOL=THREADOLET SOL=SOCKOLET WOL=WELDOLET	ISOMETRIC	 		

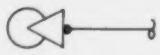
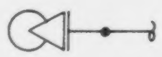
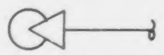
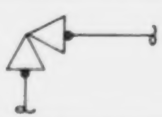
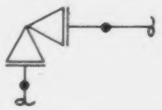
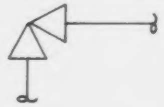
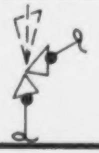
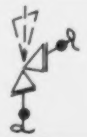
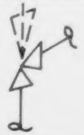
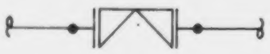
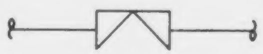
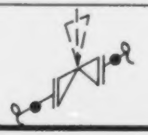
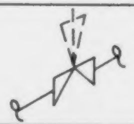
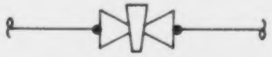
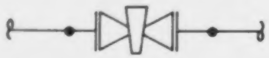
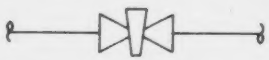
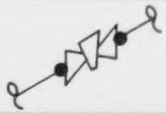
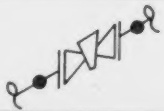
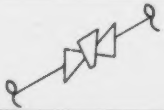
Student Supplement 5—Valve Symbols
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
GLOBE VALVE	PLAN & ELEVATION			
	ISOMETRIC			
GATE VALVE	PLAN & ELEVATION			
	ISOMETRIC			
CHECK VALVE	PLAN & ELEVATION			
	ISOMETRIC			

Student Supplement 5
Courtesy of Fluor Corporation

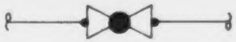
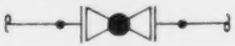
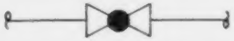
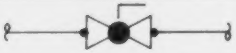
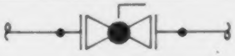
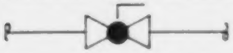
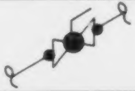
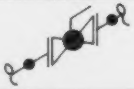
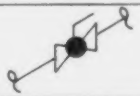
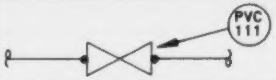
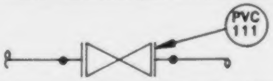
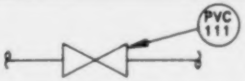
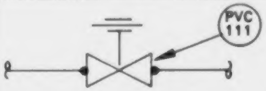
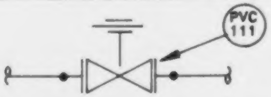
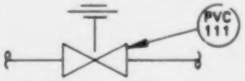
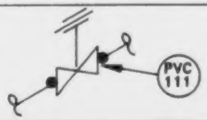
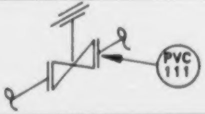
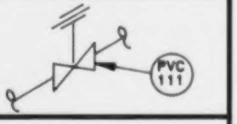
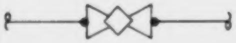
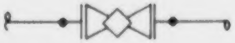
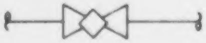
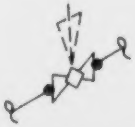
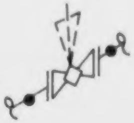
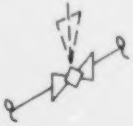
NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
STOP CHECK (ANGLE) VALVE	PLAN			
	ELEVATION			
	ISOMETRIC			
STOP CHECK (STRAIGHT) VALVE	PLAN & ELEVATION			
	ISOMETRIC			
BUTTERFLY VALVE	PLAN & ELEVATION			
	ISOMETRIC			

Student Supplement 5
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
ANGLE VALVE	PLAN			
	ELEVATION			
	ISOMETRIC			
DIAPHRAGM VALVE	PLAN & ELEVATION			
	ISOMETRIC			
PLUG VALVE	PLAN & ELEVATION			
	ISOMETRIC			

PDCAD-31

Student Supplement 5
Courtesy of Fluor Corporation

NAME		BUTT WELD	FLANGED	SCREWED OR SOCKET WELD
BALL VALVE	PLAN			
	ELEVATION			
	ISOMETRIC			
CONTROL VALVE	PLAN			
	ELEVATION			
	ISOMETRIC			
ORBIT VALVE	PLAN & ELEVATION			
	ISOMETRIC			

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 6—Gate Valve Data
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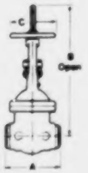
Gate Valves, Class 150, 2″ to 48″
No. 47, Flanged, No. 47 1/2, Butt Welding

Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches			
			A		B	C
	47	47½	47	47½		
2	46	45	7.0	8.50	15.75	8.0
2½	70	60	7.5	9.50	16.50	8.0
3	76	62	8.0	11.12	18.88	9.0
4	110	95	9.0	12.00	23.00	10.0
5	155	140	10.0	15.00	27.88	12.0
6	175	165	10.5	15.88	31.00	12.0
8	310	260	11.5	16.50	38.75	14.0
10	455	410	13.0	18.00	46.75	16.0
12	650	580	14.0	19.75	55.00	18.0
14	860	730	15.0	22.50	60.50	20.0
16	1120	960	16.0	24.00	66.75	20.0
18	1400	1250	17.0	26.00	76.50	24.0
20	2125	1855	18.0	28.00	89.00	30.0
24	3120	2500	20.0	32.00	104.00	36.0
*30	4520	4150	24.0	36.00	129.50	37.75
*36	6860	6800	28.0	40.00	143.50	—
*42	—	—	31.0	43.00	168.70	—
*48	—	—	34.0	46.00	190.75	—

*Equipped with solid wedge disc.

Student Supplement 6

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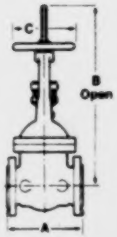
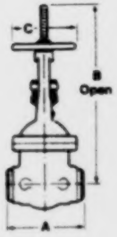
Gate Valves, Class 300, 2″ to 30″
No. 33, Flanged, No. 33 1/2, Butt Welding

Weights and Dimensions





Valve Size	Weight—Pounds		Dimensions—Inches		
	33	33½	A	B	C
			33 & 33½		
2	74	49	8.50	18.00	8.0
2½	80	74	9.50	19.00	8.0
3	108	85	11.12	19.88	9.0
4	165	120	12.00	23.75	10.0
5	235	185	15.00	28.38	12.0
6	320	245	15.88	32.50	14.0
8	500	410	16.50	40.75	16.0
10	760	625	18.00	49.50	18.0
12	1020	890	19.75	57.25	20.0
14	1380	1220	30.00	61.25	20.0
16	1960	1620	33.00	71.50	24.0
18	2450	2000	36.00	78.00	24.0
20	3890	3370	39.00	95.75	30.0
24	5955	4675	45.00	113.00	36.0
*30	8700	7500	55.00	134.00	—

*Equipped with solid wedge disc.

Student Supplement 6
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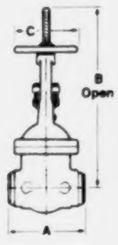
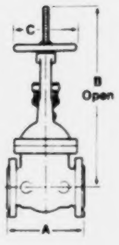
Gate Valves, Class 600, 2″ to 24″
No. 76, Flanged, No. 76 1/2, Butt Welding

Weights and Dimensions





Valve Size	Weight—Pounds		Dimensions—Inches		
	76	76½	A 76 & 76½	B	C
2	84	72	11.5	16.50	8.0
2½	130	112	13.0	20.00	9.0
3	160	140	14.0	22.62	10.0
4	300	270	17.0	28.62	12.0
6	640	520	22.0	38.62	18.0
8	1080	940	26.0	47.25	20.0
10	1550	1250	31.0	58.25	24.0
12	2100	1800	33.0	68.12	30.0
14	2900	2250	35.0	75.50	33.5
16	3550	2700	39.0	80.75	33.5
18	4600	3900	43.0	88.25	38.0
20	5325	4400	47.0	88.25	38.0
24	8400	7050	55.0	104.50	43.0

Student Supplement 6

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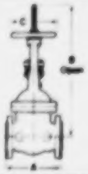
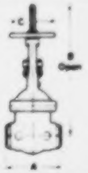
Gate Valves, Class 900, 2″ to 16″
No. 83, Flanged, No. 83 1/2, Butt Welding
Gate Valves, Class 1500, 2″ to 12″
No. 87, Flanged, No. 87 1/2, Butt Welding



Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches			Valve Size	Weight—Pounds		Dimensions—Inches		
	83	83½	A	B	C		87	87½	A	B	C
			83 & 83½						87 & 87½		
2	210	180	14.5	24.50	12.0	2	210	175	14.50	24.50	12.0
2½	280	240	16.5	27.75	14.0	2½	285	245	16.50	27.75	14.0
3	275	230	15.0	27.75	14.0	3	400	320	18.50	30.25	16.0
4	425	365	18.0	32.50	16.0	4	600	485	21.50	35.50	18.0
6	840	730	24.0	42.00	20.0	6	1400	1250	27.75	46.75	24.0
8	1400	1150	29.0	52.00	24.0	8	2200	1875	32.75	55.12	30.0
10	2000	1600	33.0	60.62	30.0	10	4850	4300	39.00	63.00	34.0
12	3400	2900	38.0	72.50	34.0	12	7300	6300	44.50	72.50	38.0
14	4800	4000	40.5	84.12	34.0						
16	6800	5850	44.5	93.75	38.0						

Introduction to Pipe Drafting With
Unit 1

Student Supplement 7—Globe Valve Data
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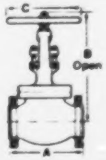
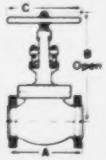
Globe Valves, Class 150, 2″ to 14″
No. 143, Flanged, No. 143 1/2, Butt Welding
Globe Valves, Class 300, 2″ to 12″
No. 151, Flanged, No. 151 1/2, Butt Welding



Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches			Valve Size	Weight—Pounds		Dimensions—Inches		
	143	143½	A	B	C		151	151½	A	B	C ·
			143 & 143½	143 & 143½					151 & 151½	151 & 151½	
2	47	43	8.0	15.00	8.0	2	60	48	10.50	16.75	8.0
2½	66	60	8.5	17.12	10.0	2½	88	73	11.50	19.00	10.0
3	82	73	9.5	18.50	10.0	3	117	97	12.50	21.00	10.0
4	134	112	11.5	21.00	12.0	4	176	140	14.00	24.00	12.0
5	199	165	14.0	23.00	12.0	5	290	240	15.75	27.50	12.0
6	240	195	16.0	25.50	14.0	6	340	280	17.50	31.00	16.0
8	370	330	19.5	30.00	16.0	8	530	460	22.00	34.25	20.0
10	525	480	24.5	34.00	20.0	10	750	620	24.50	36.00	20.0
12	900	820	27.5	39.50	24.0	12	1100	900	28.00	37.25	24.0
14	1000	880	31.0	41.38	24.0						

Student Supplement 7

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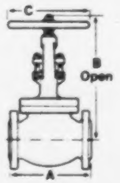
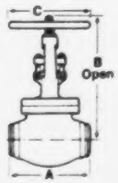
Globe Valves, Class 600, 2" to 8"
No. 171, Flanged, No. 171 1/2, Butt Welding
Globe Valves, Class 900, 2" to 8"
No. 183, Flanged, No. 183 1/2, Butt Welding
Globe Valves, Class 1500, 2" to 6"
No. 189, Flanged, No. 189 1/2, Butt Welding

Weight—Pounds			Dimensions—Inches		
			A	B	
Valve Size	171	171½	171 & 171½	171 & 171½	C
2	88	79	11.5	18.75	10.0
2½	126	100	13.0	20.25	10.0
3	160	135	14.0	23.00	12.0
4	270	215	17.0	26.50	14.0
6	550	490	22.0	35.00	18.0
8	1000	790	26.0	37.25	20.0





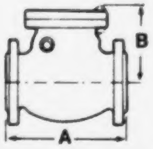
Weight—Pounds			Dimensions—Inches		
			A	B	
Valve Size	183	183½	183 & 183½	183 & 183½	C
2	192	176	14.5	23.62	12.0
2½	290	250	16.5	26.00	14.0
3	270	225	15.0	26.12	14.0
4	400	370	18.0	31.50	20.0
6	960	850	24.0	40.00	24.0
8	1600	1400	29.0	45.12	24.0

Weight—Pounds			Dimensions—Inches		
			A		
Valve Size	189	189½	189 & 189½	B	C
2	190	176	14.5	23.62	12.0
2½	290	250	16.5	26.00	14.0
3	550	485	18.5	30.38	20.0
4	960	850	21.5	33.50	20.0
6	1200	1000	27.75	45.00	24.0

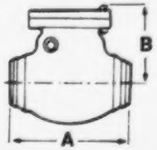
Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 8—Swing Check Valve Data
©1992-Crane Valves. Reprinted with permission.

Swing Check Valves, Class 150, 2″ to 24″
No. 147, Flanged, No. 147 1/2, Butt Welding
Swing Check Valves, Class 300, 2″ to 24″
No. 159, Flanged, No. 159 1/2, Butt Welding



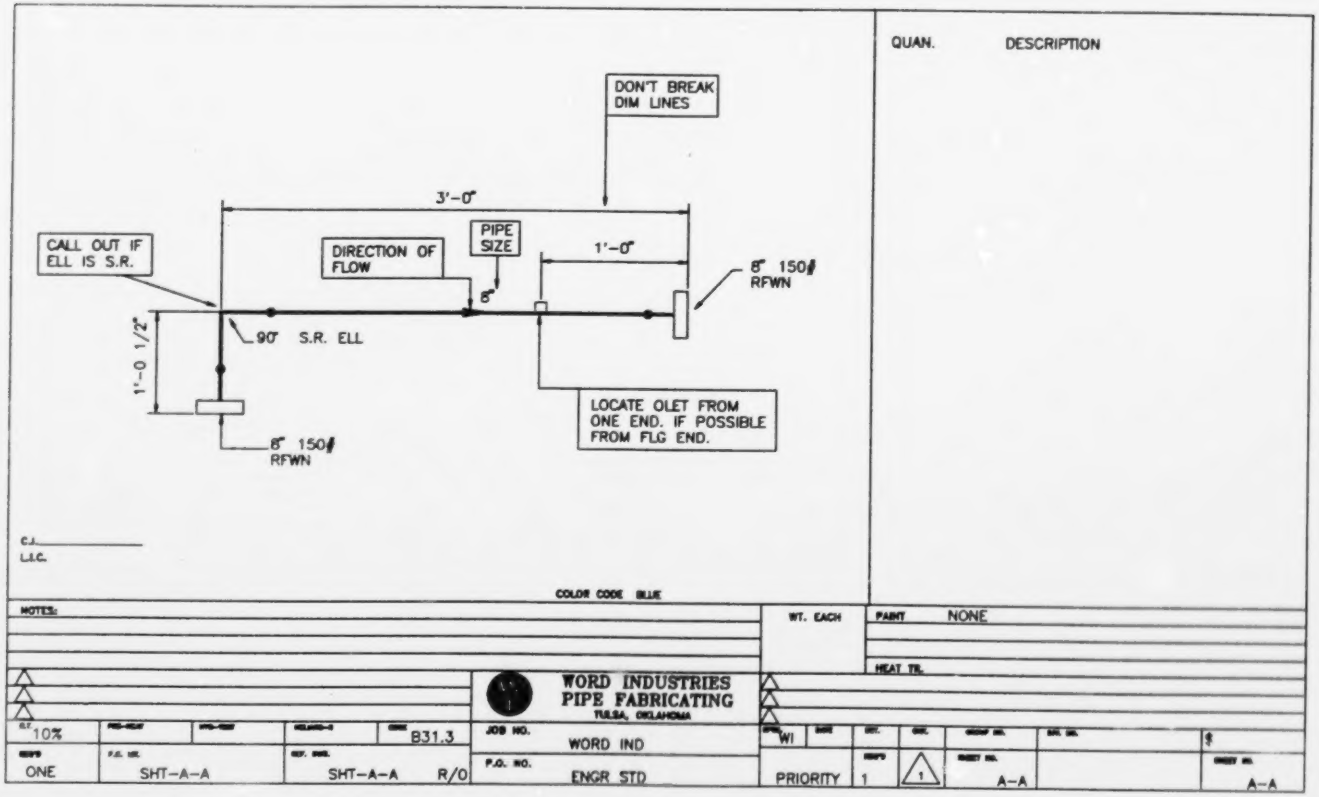
Weights and Dimensions



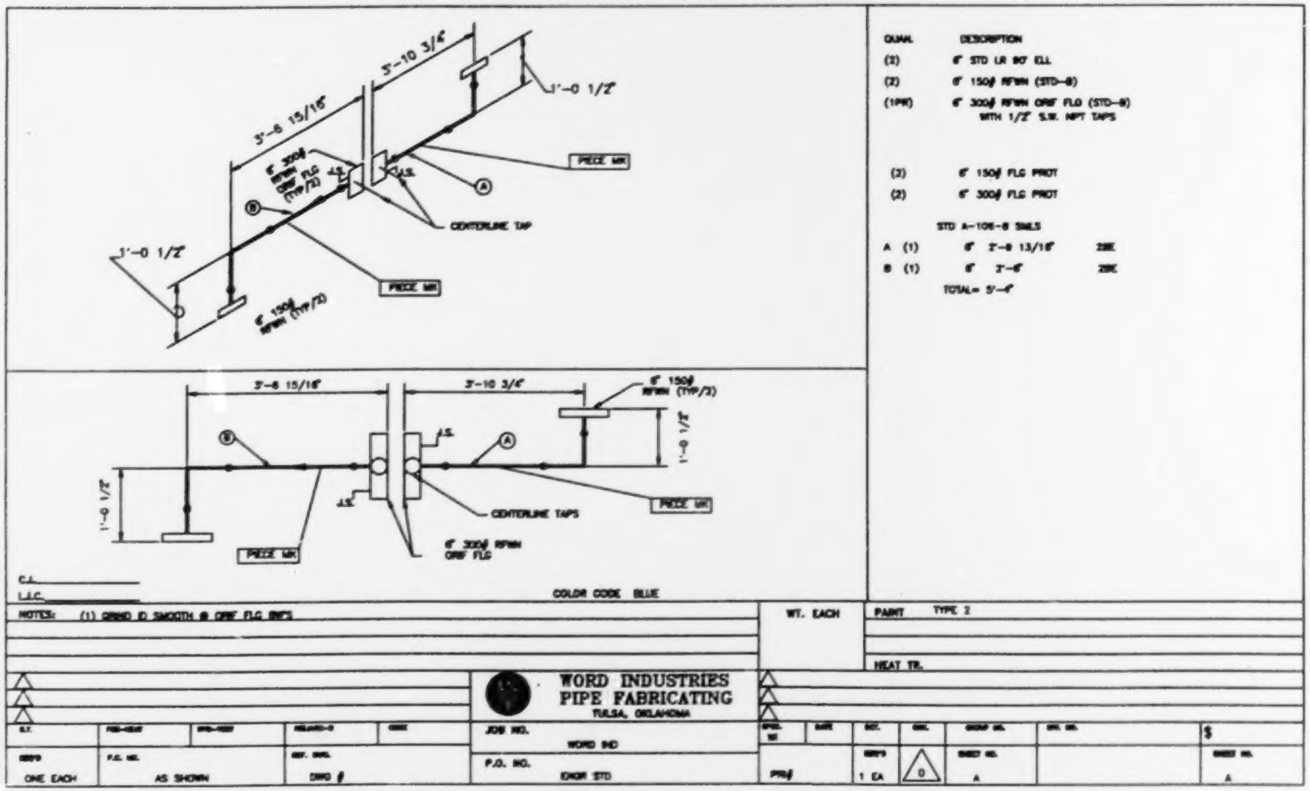
Valve Size	Weight—Pounds		Dimensions—Inches		Valve Size	Weight—Pounds		Dimensions—Inches	
	147	147½	A	B		159	159½	A	B
			147 & 147½					159 & 159½	
2	33	26	8.0	6.75	2	46	33	10.50	6.75
2½	57	37	8.5	7.12	2½	66	49	11.50	7.38
3	59	40	9.5	7.38	3	86	66	12.50	8.50
4	93	71	11.5	8.50	4	154	97	14.00	9.25
5	152	126	13.0	9.50	5	255	203	15.75	10.62
6	165	132	14.0	10.25	6	276	216	17.50	11.88
8	275	235	19.5	11.88	8	420	330	21.00	13.38
10	440	385	24.5	13.88	10	640	500	24.50	13.88
12	680	570	27.5	15.75	12	1000	830	28.00	16.62
14	950	810	31.0	17.75	14	1550	1100	33.00	18.88
16	1225	1065	34.0	19.00	16	1700	1400	34.00	20.50
18	1700	1500	38.5	21.25	18	2200	1900	38.50	23.62
20	1850	1600	38.5	23.58	20	2800	2425	40.00	26.38
24	2900	2550	51.0	26.75	24	3650	3100	53.00	29.62

Introduction to Pipe Drafting With CAD
Unit 1

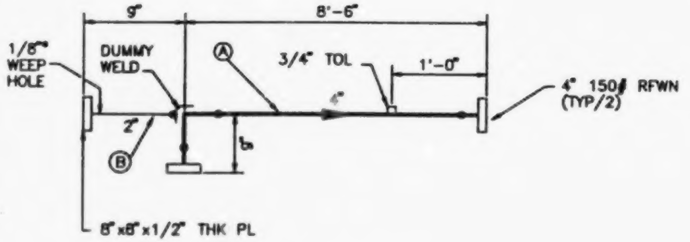
Student Supplement 9—Company Standards
Examples courtesy of Word Industries Pipe Fabricating, Tulsa, Oklahoma


QUAN.
DESCRIPTION
DON'T BREAK DIM LINES
3'-0"
1'-0"
CALL OUT IF ELL IS S.R.
DIRECTION OF FLOW
PIPE SIZE
8"
8" 150#
RFWN
90° S.R. ELL
1'-0 1/2"
8" 150#
RFWN
LOCATE OLET FROM ONE END. IF POSSIBLE FROM FLG END.
C.J.
L.I.C.
COLOR CODE BLUE
NOTES:
WT. EACH
PAINT NONE
HEAT TR.
WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA
10%
B31.3
JOB NO.
WORD IND
WI
ONE
SHT-A-A
SHT-A-A
R/0
P.O. NO.
ENGR STD
PRIORITY
1
1
A-A
A-A

Student Supplement 9
Courtesy of Word Industries Pipe Fabricating, Tulsa, Oklahoma


3'-8 15/16"
3'-10 3/4"
1'-0 1/2"
1'-0 1/2"
6" 300# RFWN ORIF FLG (TYP/2)
J.S.
B
A
PIECE MK
PIECE MK
CENTERLINE TAP
6" 150# RFWN (TYP/2)
3'-8 15/16"
3'-10 3/4"
6" 150# RFWN (TYP/2)
1'-0 1/2"
1'-0 1/2"
J.S.
J.S.
CENTERLINE TAPS
PIECE MK
PIECE MK
6" 300# RFWN ORIF FLG
QUAN.
DESCRIPTION
(2) 6" STD LR 90° ELL
(2) 6" 150# RFWN (STD-B)
(1PR) 6" 300# RFWN ORIF FLG (STD-B) WITH 1/2" S.W. NPT TAPS
(2) 6" 150# FLG PROT
(2) 6" 300# FLG PROT
STD A-106-B SMLS
A (1) 6" 2'-8 13/16" 2BE
B (1) 6" 2'-6" 2BE
TOTAL= 5'-4"
C.L.
L.I.C.
COLOR CODE BLUE
NOTES: (1) GRIND ID SMOOTH @ ORIF FLG BWS
WT. EACH
PAINT TYPE 2
HEAT TR.
WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA
JOB NO.
WORD IND
P.O. NO.
ENGR STD
ONE EACH
AS SHOWN
DWG #
1 EA
0
A
A
$

Student Supplement 9
Courtesy of Word Industries Pipe Fabricating, Tulsa, Oklahoma



9"
8'-6"
1/8"* WEEP HOLE
DUMMY WELD
Ⓐ
3/4" TOL
1'-0"
4" 150# RFWN (TYP/2)
4"
2"
Ⓑ
8"x8"x1/2" THK PL

• LOCATE POINTER ON THE SIDE THAT THE WEEP HOLE NEEDS TO BE LOCATED ON HORIZONTAL SUPT. FOR DRAINAGE.

QUAN.	DESCRIPTION
(1)	4" X-HVY LR 90° ELL
(2)	4" 150# RFWN (X-HVY-B)
(1)	3/4" ON 4" 6000# T-O-L
(2)	4" 150# FLG PROT
	X-HVY A106-B SMLS
A (1)	4" 7'-9" 2BE
	SUPT MAT'L X-HVY A106-B SMLS
B (1)	2" 0'-10 1/16" 2PE
(1)	8"x8"x1/2" THK CS PLATE

C.I. ____________

L.I.C. ____________

COLOR CODE BLUE

NOTES:

WT. EACH

PAINT NONE

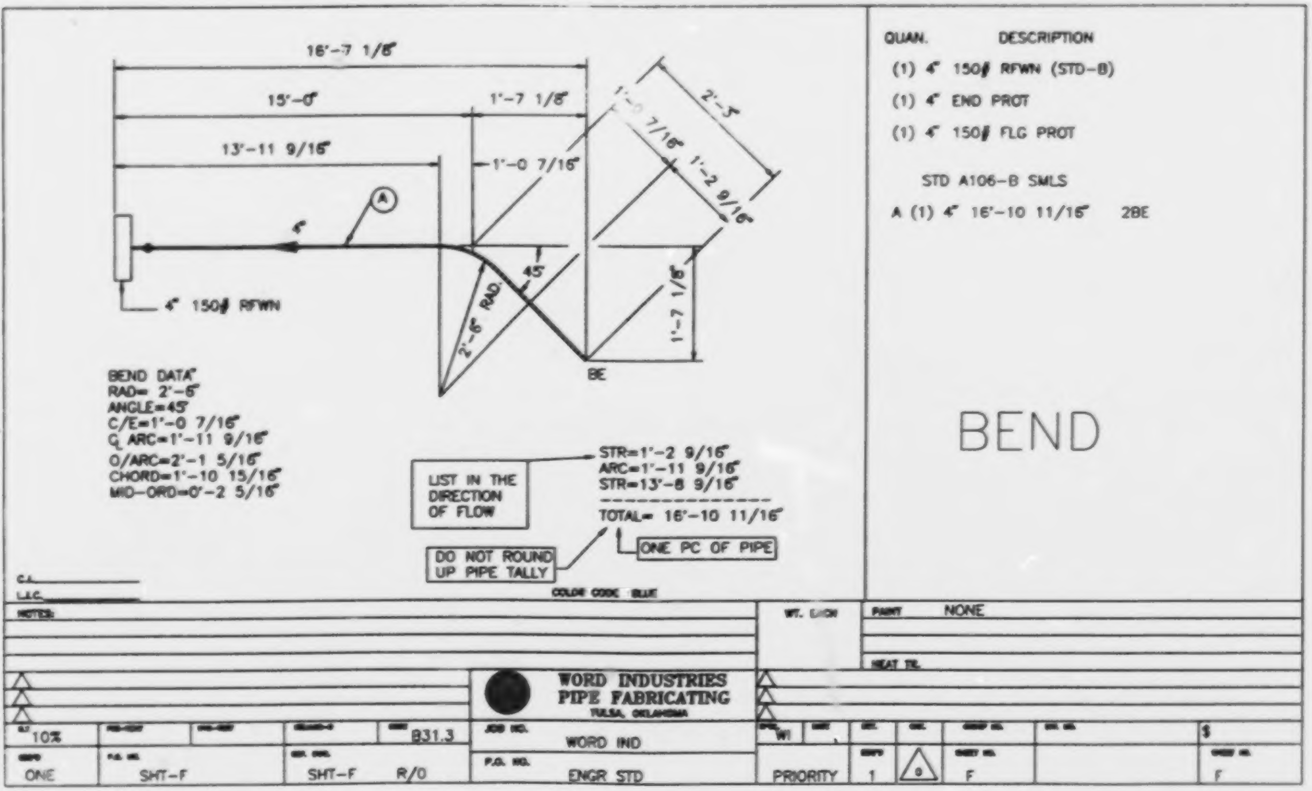
HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA

10%				B31.3	JOB NO. WORD IND	WI
ONE	P.C. NO. SHT-D		SHT-D R/0		P.O. NO. ENGR STD	PRIORITY

					$
1	0	SHEET NO. D			SHEET NO. D

Student Supplement 9
Courtesy of Word Industries Pipe Fabricating, Tulsa, Oklahoma


16'-7 1/8"
15'-0"
1'-7 1/8"
13'-11 9/16"
1'-0 7/16"
1'-0 7/16"
2'-3"
1'-2 9/16"
A
4"
45°
2'-6" RAD.
1'-7 1/8"
BE
4" 150# RFWN
BEND

BEND DATA"
RAD= 2'-6"
ANGLE=45°
C/E=1'-0 7/16"
℄ ARC=1'-11 9/16"
O/ARC=2'-1 5/16"
CHORD=1'-10 15/16"
MID-ORD=0'-2 5/16"

LIST IN THE DIRECTION OF FLOW

STR=1'-2 9/16"
ARC=1'-11 9/16"
STR=13'-8 9/16"

TOTAL= 16'-10 11/16"

DO NOT ROUND UP PIPE TALLY

ONE PC OF PIPE

QUAN.	DESCRIPTION
(1)	4" 150# RFWN (STD-B)
(1)	4" END PROT
(1)	4" 150# FLG PROT
	STD A106-B SMLS
A (1)	4" 16'-10 11/16" 2BE

C.L.
L.I.C.
COLOR CODE BLUE
NOTES:
WT. EACH
PAINT NONE
HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA

10%
B31.3
JOB NO. WORD IND
P.O. NO. ENGR STD
ONE
SHT-F
SHT-F R/0
WI
PRIORITY
1
0
F
$
F

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 10—Butt Welding Fittings
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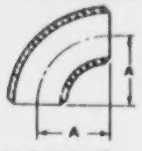
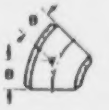
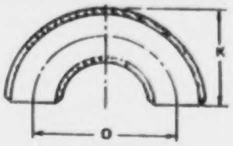


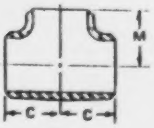
90°ELBOWS



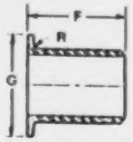
45° ELBOWS



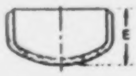
180° RETURNS



TEES



LAP JOINT STUB ENDS

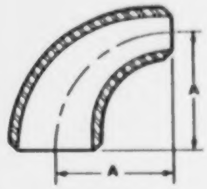


CAPS

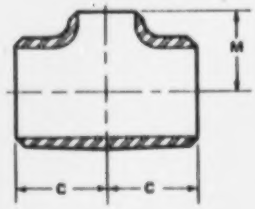
	90° Elbows			45° Elbows		180° Returns				Tees		Lap Joint Stub Ends			Caps
Nom. Pipe Size	Long Rad. A	Short Rad A	3 Rad. A	LR B	3 Rad B	Long Rad. O	Long Rad. K	Short Rad. O	Short Rad. K	C	M	F	G	R	E
1/2	1.50			0.62		3.00	1.88			1.00	1.00	3.00	1.38	0.12	1.00
3/4	1.12			0.44		2.25	1.69			1.12	1.12	3.00	1.69	0.12	1.00
1	1.50	1.00		0.88		3.00	2.19	2.00	1.62	1.50	1.50	4.00	2.00	0.12	1.50
1-1/4	1.88	1.25		1.00		3.75	2.75	2.50	2.06	1.88	1.88	4.00	2.50	0.19	1.50
1-1/2	2.25	1.50		1.12		4.50	3.25	3.00	2.44	2.25	2.25	4.00	2.88	0.25	1.50
2	3.00	2.00	6.00	1.38	2.50	6.00	4.19	4.00	3.19	2.50	2.50	6.00	3.62	0.31	1.50
2-1/2	3.75	2.50	7.50	1.75	3.12	7.50	5.19	5.00	3.94	3.00	3.00	6.00	4.12	0.31	1.50
3	4.50	3.00	9.00	2.00	3.75	9.00	6.25	6.00	4.75	3.38	3.38	6.00	5.00	0.38	2.00
3-1/2	5.25	3.50	10.50	2.25	-	10.50	7.25	7.00	5.50	3.75	3.75	6.00	5.50	0.38	2.50
4	6.00	4.00	12.00	2.50	5.00	12.00	8.25	8.00	6.25	4.12	4.12	6.00	6.19	0.44	2.50
5	7.50	5.00	15.00	3.12	-	15.00	10.31	10.00	7.75	4.88	4.88	8.00	7.31	0.44	3.00
6	9.00	6.00	18.00	3.75	7.44	18.00	12.31	12.00	9.31	5.62	5.62	8.00	8.50	0.50	3.50
8	12.00	8.00	24.00	5.00	9.94	24.00	16.31	16.00	12.31	7.00	7.00	8.00	10.62	0.50	4.00
10	15.00	10.00	30.00	6.25	12.44	30.00	20.38	20.00	15.38	8.50	8.50	10.00	12.75	0.50	5.00
12	18.00	12.00	36.00	7.50	14.88	36.00	24.38	24.00	18.38	10.00	10.00	10.00	15.00	0.50	6.00
14	21.00	14.00	42.00	8.75	17.38	42.00	28.00	28.00	21.00	11.00	11.00	12.00	16.25	0.50	6.50
16	24.00	16.00	48.00	10.00	19.88	48.00	32.00	32.00	24.00	12.00	12.00	12.00	18.50	0.50	7.00
18	27.00	18.00	54.00	11.25	22.38	54.00	36.00	36.00	27.00	13.50	13.50	12.00	21.00	0.50	8.00
20	30.00	20.00	60.00	12.50	24.88	60.00	40.00	40.00	30.00	15.00	15.00	12.00	23.00	0.50	9.00
22	33.00	22.00	66.00	13.50	27.31	66.00	44.00	44.00	33.00	16.50	16.50	12.00	25.25	0.50	10.00
24	36.00	24.00	72.00	15.00	29.81	72.00	48.00	48.00	36.00	17.00	17.00	12.00	27.25	0.50	10.50
26	39.00		78.00	16.00	32.31					19.50	19.50				10.50
28	42.00		84.00	17.25	34.75					20.50	20.50				10.50
30	45.00		90.00	18.50	37.25					22.00	22.00				10.50
32	48.00		-	19.75	-					23.50	23.50				10.50
34	51.00		102.00	21.00	42.25					25.00	25.00				10.50
36	54.00		108.00	22.25	44.88					26.50	26.50				10.50
38	57.00		114.00	23.62	47.25					28.00	28.00				12.00
40	60.00		120.00	24.88	49.75					29.50	29.50				12.00
42	63.00		126.00	26.00	52.19					30.00	28.00				12.00
44	66.00		132.00	27.38	54.69					32.00	30.00				13.50
46	69.00		138.00	28.62	57.19					33.50	31.50				13.50
48	72.00		144.00	29.88	59.66					35.00	33.00				13.50

All dimensions given in inches. For common diameters and wall thicknesses, see page 8.
Dimensions in accordance with ANSI B16.9 and B16.28.
Other sizes, schedules and wall thicknesses also available.

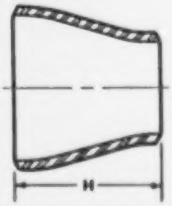
Student Supplement 10
Courtesy of The Ladish Company



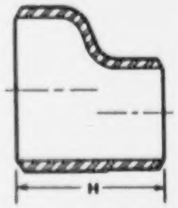
90° L.R.
REDUCING ELBOWS



REDUCING
OUTLET TEES



CONCENTRIC
REDUCERS

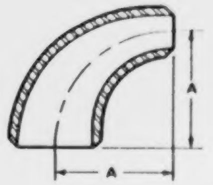


ECCENTRIC
REDUCERS

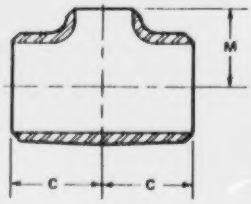
Nom. Pipe Size	90° L.R. Reducing Elbows	Reducing Outlet Tees		Concentric & Eccentric Reducers
	A	C	M	H
1/2x3/8		1.00	1.00	
1/2x1/4		1.00	1.00	
3/4x1/2		1.12	1.12	1.50
3/4x3/8		1.12	1.12	1.50
1x3/4		1.50	1.50	2.00
1x1/2		1.50	1.50	2.00
1-1/4x1		1.88	1.88	2.00
1-1/4x3/4		1.88	1.88	2.00
1-1/4x1/2		1.88	1.88	2.00
1-1/2x1-1/4		2.25	2.25	2.50
1-1/2x1		2.25	2.25	2.50
1-1/2x3/4		2.25	2.25	2.50
1-1/2x1/2		2.25	2.25	2.50
2x1-1/2	3.00	2.50	2.38	3.00
2x1-1/4	3.00	2.50	2.25	3.00
2x1	3.00	2.50	2.00	3.00
2x3/4		2.50	1.75	3.00
2-1/2x2	3.75	3.00	2.75	3.50
2-1/2x1-1/2	3.75	3.00	2.62	3.50
2-1/2x1-1/4	3.75	3.00	2.50	3.50
2-1/2x1		3.00	2.25	3.50
3x2-1/2	4.50	3.38	3.25	3.50
3x2	4.50	3.38	3.00	3.50
3x1-1/2	4.50	3.38	2.88	3.50
3x1-1/4		3.38	2.75	3.50
3-1/2x3	5.25	3.75	3.62	4.00
3-1/2x2-1/2	5.25	3.75	3.50	4.00
3-1/2x2	5.25	3.75	3.25	4.00
3-1/2x1-1/2		3.75	3.12	4.00
3-1/2x1-1/4				4.00
4x3-1/2	6.00	4.12	4.00	4.00
4x3	6.00	4.12	3.88	4.00
4x2-1/2	6.00	4.12	3.75	4.00
4x2	6.00	4.12	3.50	4.00
4x1-1/2		4.12	3.38	4.00
5x4	7.50	4.88	4.62	5.00
5x3-1/2	7.50	4.88	4.50	5.00
5x3	7.50	4.88	4.38	5.00
5x2-1/2	7.50	4.88	4.25	5.00
5x2		4.88	4.12	5.00
6x5	9.00	5.62	5.38	5.50
6x4	9.00	5.62	5.12	5.50
6x3-1/2	9.00	5.62	5.00	5.50
6x3	9.00	5.62	4.88	5.50
6x2-1/2		5.62	4.75	5.50
8x6	12.00	7.00	6.62	6.00
8x5	12.00	7.00	6.38	6.00
8x4	12.00	7.00	6.12	6.00
8x3-1/2		7.00	6.00	6.00
10x8	15.00	8.50	8.00	7.00
10x6	15.00	8.50	7.62	7.00
10x5	15.00	8.50	7.50	7.00
10x4		8.50	7.25	7.00
12x10	18.00	10.00	9.50	8.00
12x8	18.00	10.00	9.00	8.00
12x6	18.00	10.00	8.62	8.00
12x5		10.00	8.50	8.00
14x12	21.00	11.00	10.62	13.00
14x10	21.00	11.00	10.12	13.00
14x8	21.00	11.00	9.75	13.00
14x6		11.00	9.38	13.00
16x14	24.00	12.00	12.00	14.00
16x12	24.00	12.00	11.62	14.00
16x10	24.00	12.00	11.12	14.00
16x8		12.00	10.75	14.00
16x6		12.00	10.38	
18x16	27.00	13.50	13.00	15.00
18x14	27.00	13.50	13.00	15.00
18x12	27.00	13.50	12.62	15.00
18x10	27.00	13.50	12.12	15.00
18x8		13.50	11.75	

All dimensions given in inches. For common diameters and wall thicknesses, see page 6.
Dimensions in accordance with ANSI B16.9.
Other sizes, schedules and wall thicknesses also available.

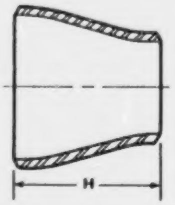
Student Supplement 10
Courtesy of The Ladish Company



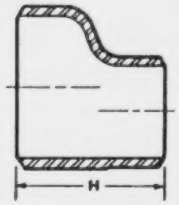
90° L.R.
REDUCING
ELBOWS



REDUCING
OUTLET
TEES



CONCENTRIC
REDUCERS



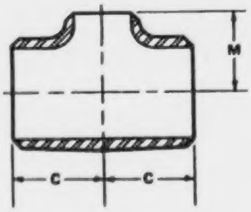
ECCENTRIC
REDUCERS

Nom Pipe Size	90 L.R. Reducing Elbows A	Reducing Outlet Tees C	Reducing Outlet Tees M	Concentric & Eccentric Reducers H
20x18	30.00	15.00	14.50	20.00
20x16	30.00	15.00	14.00	20.00
20x14	30.00	15.00	14.00	20.00
20x12	30.00	15.00	13.62	20.00
20x10	30.00	15.00	13.12	
20x8		15.00	12.75	
22x20		16.50	16.00	20.00
22x18		16.50	15.50	20.00
22x16		16.50	15.00	20.00
22x14		16.50	15.00	20.00
22x12		16.50	14.62	
22x10		16.50	14.12	
24x22	36.00	17.00	17.00	20.00
24x20	36.00	17.00	17.00	20.00
24x18	36.00	17.00	16.50	20.00
24x16	36.00	17.00	16.00	20.00
24x14	36.00	17.00	16.00	
24x12	36.00	17.00	15.62	
24x10		17.00	15.12	
26x24		19.50	19.00	24.00
26x22		19.50	18.50	24.00
26x20		19.50	18.00	24.00
26x18		19.50	17.50	24.00
26x16		19.50	17.00	
26x14		19.50	17.00	
26x12		19.50	16.62	
28x26		20.50	20.50	24.00
28x24		20.50	20.00	24.00
28x22		20.50	19.50	
28x20		20.50	19.00	24.00
28x18		20.50	18.50	24.00
28x16		20.50	18.00	
28x14		20.50	18.00	
28x12		20.50	17.62	

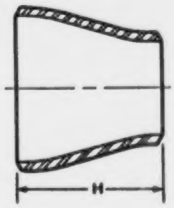
Nom. Pipe Size	Reducing Outlet Tees C	Reducing Outlet Tees M	Concentric & Eccentric Reducers H
30x28	22.00	21.50	24.00
30x26	22.00	21.50	24.00
30x24	22.00	21.00	24.00
30x22	22.00	20.50	
30x20	22.00	20.00	24.00
30x18	22.00	19.50	
30x16	22.00	19.00	
30x14	22.00	19.00	
30x12	22.00	18.62	
30x10	22.00	18.12	
32x30	23.50	23.00	24.00
32x28	23.50	22.50	24.00
32x26	23.50	22.50	24.00
32x24	23.50	22.00	24.00
32x22	23.50	21.50	
32x20	23.50	21.00	
32x18	23.50	20.50	
32x16	23.50	20.00	
32x14	23.50	20.00	
34x32	25.00	24.50	24.00
34x30	25.00	24.00	24.00
34x28	25.00	23.50	
34x26	25.00	23.50	24.00
34x24	25.00	23.00	24.00
34x22	25.00	22.50	
34x20	25.00	22.00	
34x18	25.00	21.50	
34x16	25.00	21.00	
36x34	26.50	26.00	24.00
36x32	26.50	25.50	24.00
36x30	26.50	25.00	24.00
36x26	26.50	24.50	24.00
36x24	26.50	24.00	24.00

All dimensions given in inches. For common diameters and wall thicknesses, see page 6
Dimensions in accordance with ANSI B16.9
Other sizes, schedules and wall thicknesses also available

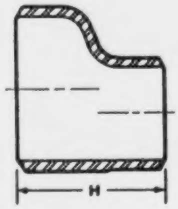
Student Supplement 10
Courtesy of The Ladish Company



REDUCING
OUTLET TEES



CONCENTRIC
REDUCERS



ECCENTRIC
REDUCERS

Nom. Pipe Size	Reducing Outlet Tees C	Reducing Outlet Tees M	Concentric & Eccentric Reducers H
36x18	26.50	22.50	
36x16	26.50	22.00	
38x36	28.00	28.00	24.00
38x34	28.00	27.50	24.00
38x32	28.00	27.00	24.00
38x30	28.00	26.50	24.00
38x28	28.00	25.50	24.00
38x26	28.00	25.50	24.00
38x24	28.00	25.00	
38x22	28.00	24.50	
38x20	28.00	24.00	
38x18	28.00	23.50	
40x38	29.50	29.50	24.00
40x36	29.50	29.00	24.00
40x34	29.50	28.50	24.00
40x32	29.50	28.00	24.00
40x30	29.50	27.50	24.00
40x28	29.50	26.50	
40x26	29.50	26.50	
40x24	29.50	26.00	
40x22	29.50	25.50	
40x20	29.50	25.00	
40x18	29.50	24.50	
42x40	30.00	28.00	24.00
42x38	30.00	28.00	24.00
42x36	30.00	28.00	24.00
42x34	30.00	28.00	24.00
42x32	30.00	28.00	24.00
42x30	30.00	28.00	24.00
42x28	30.00	27.50	
42x26	30.00	27.50	
42x24	30.00	26.00	
42x22	30.00	26.00	
42x20	30.00	26.00	
42x18	30.00	25.50	
42x16	30.00	25.00	

Nom. Pipe Size	Reducing Outlet Tees C	Reducing Outlet Tees M	Concentric & Eccentric Reducers H
44x42	32.00	30.00	24.00
44x40	32.00	29.50	24.00
44x38	32.00	29.00	24.00
44x36	32.00	28.50	24.00
44x34	32.00	28.50	
44x32	32.00	28.00	
44x30	32.00	28.00	
44x28	32.00	27.50	
44x26	32.00	27.50	
44x24	32.00	27.50	
44x22	32.00	27.00	
44x20	32.00	27.00	
46x44	33.50	31.50	28.00
46x42	33.50	31.00	28.00
46x40	33.50	30.50	28.00
46x38	33.50	30.00	28.00
46x36	33.50	30.00	
46x34	33.50	29.50	
46x32	33.50	29.50	
46x30	33.50	29.00	
46x28	33.50	29.00	
46x26	33.50	29.00	
46x24	33.50	28.50	
46x22	33.50	28.50	
48x46	35.00	33.00	28.00
48x44	35.00	33.00	28.00
48x42	35.00	32.00	28.00
48x40	35.00	32.00	28.00
48x38	35.00	32.00	
48x36	35.00	31.00	
48x34	35.00	31.00	
48x32	35.00	31.00	
48x30	35.00	30.00	
48x28	35.00	30.00	
48x26	35.00	30.00	
48x24	35.00	29.00	
48x22	35.00	29.00	

All dimensions given in inches. For common diameters and wall thicknesses, see page 6
Dimensions in accordance with ANSI B16.9
Other sizes, schedules and wall thicknesses also available

Student Supplement 10
Courtesy of The Ladish Company

BUTT WELDING FITTINGS

APPROXIMATE WEIGHT (LBS.)

Nom. Pipe Size	90° Elbows								45° Elbows				180° Return Long Radius	
	Long Radius				Short Radius		3 Radius		Long Radius		3 Radius			
	STD	XS	SCH 160	XXS	STD	XS	STD	XS	STD	XS	STD	XS	STD	XS
1/2	.18	.25							.09	.19			.35	
3/4	.19	.25							.09	.19			.40	.65
1	.40	.50	.60	.75	.25				.25	.31			.75	1.00
1-1/4	.60	.90	1.00	1.38	.40				.38	.50			1.25	1.75
1-1/2	.90	1.15	1.80	1.50	.56	.75			.40	.69			1.88	2.39
2	1.60	2.20	3.25	3.50	1.00	1.50	3	4	.81	1.19	1.5	2.1	3.23	4.40
2-1/2	3.25	4.00	5.13	7.00	2.13	2.80	6	8	1.75	2.13	3	4	6.50	8.00
3	5.00	6.50	8.50	11.00	3.00	4.25	10	13	2.63	3.50	5	7	10.25	13.00
3-1/2	6.75	8.35		16.00	4.50	6.00	13	18	3.50	4.50	7	9	13.00	16.75
4	9.00	13.50	18.00	20.00	6.25	8.50	18	25	4.50	6.10	9	13	18.50	25.00
5	15.50	22.00	32.00	38.00	9.60	14.00	29	43	7.50	10.75	15	22	30.00	44.00
6	24.50	35.00	57.00	65.00	18.00	23.00	45	70	12.00	17.50	23	35	50.00	70.00
8	50.00	71.00	120	118	34.00	47.50	90	140	23.00	35.00	45	70	95.00	142
10	88.00	107	260		58.00	70.00	159	218	43.00	53.00	80	109	117	215
12	125	160	450		80.00	104	233	310	62.00	84.00	117	155	230	320
14	160	205	572		105	140	298	400	80.00	100	149	200	325	400
16	206	278			132	174	390	520	100	135	195	260	412	550
18	260	340			167	219	495	660	126	167	248	330	510	690
20	320	420			210	276	610	810	160	208	305	405	640	830
22	394	520					735	960	197	260	368	490	787	1040
24	460	600			298	3.92	875	1170	238	300	438	585	890	1200
26	550	729					1030	1370	275	365	515	685		
30	734	975					1370	1830	367	488	665	915		
36	1062	1412					1970	2630	531	708	985	1315		

Nom. Pipe Size	180° Returns Short Radius		Straight Tees				Lap Joint Stub Ends		Caps			
	STD	XS	STD	XS	SCH. 160	XXS	STD	XS	STD	XS	SCH 160	XXS
1/2			.35	.45	.36		.24	.32				
3/4			.45	.60	.58		.34	.44				
1	.50		.75	.88	1.00	1.25	.75	1.00	.20	.30	.40	.50
1-1/4	.80		1.30	1.60	2.00	2.50	1.10	1.25	.30	.40	.50	.75
1-1/2	1.13	1.50	2.00	2.25	3.00	3.38	1.25	1.74	.40	.50	.60	.90
2	2.00	3.00	3.50	4.00	5.00	6.25	2.25	3.00	.60	.75	1.25	1.50
2-1/2	4.25	5.60	6.00	7.00	8.00	10.50	3.50	4.50	.90	1.00	1.75	2.50
3	6.00	8.50	7.00	8.50	10.00	13.50	4.75	6.75	1.50	1.75	2.90	4.00
3-1/2	9.00	12.00	9.00	12.00		18.00	5.50	7.75	2.00	2.50		6.00
4	12.50	17.00	12.00	15.80	25.00	25.00	7.25	9.50	2.50	3.00	5.90	7.50
5	19.00	28.00	21.00	26.00	55.00	40.00	11.80	17.00	4.50	5.50	10.00	12.00
6	35.00	46.00	34.00	40.00	62.00	68.00	15.50	21.50	6.50	9.00	15.00	18.00
8	68.00	100	55.00	75.00	110	120	23.50	32.00	12.00	16.00	31.00	30.00
10	115	140	85.00	105	260		36.50	53.00	20.00	25.00	57.00	
12	155	218	120	160	480		47.00	62.00	30.00	36.00	95.00	
14	210	275	165	240			60.00	80.00	36.00	45.00		
16	260	340	195	280			70.00	93.00	40.00	54.00		
18	330	430	249	332			94.00	124	54.00	72.00		
20	410	550	342	480			105	138	75.00	86.00		
22			414	550					94.00	125		
24	590	780	528	610			126	167	96.00	130		
26			770	875					119	159		
30			1060	1200					172	229		
36			1490	1700								

Student Supplement 10
Courtesy of The Ladish Company

BUTT WELDING FITTINGS

APPROXIMATE WEIGHT (LBS.)

Nom. Pipe Size	90° L.R. Reducing Elbows		Reducing Outlet Tees				Concentric & Eccentric Reducers			
	STD	XS	STD	XS	SCH. 160	XXS	STD	XS	SCH. 160	XXS
1/2x3/8			.250	.280						
1/2x1/4			.250	.280						
3/4x1/2			.500	.500	.750	1.15	.17	.22	.28	
3/4x3/8			.500	.500	.750		.15	.20	.24	
1x3/4			.930	1.00	1.13	1.25	.40	.45	.50	.80
1x1/2			.880	1.00	1.13	1.25	.40	.45	.50	.75
1-1/4x1			1.500	1.75	2.00	2.63	.50	.50	.65	1.00
1-1/4x3/4			1.500	1.75	2.00	2.50	.40	.50	.65	1.00
1-1/4x1/2			1.500	1.75	2.00	2.38	.40	.50	.60	1.00
1-1/2x1-1/4			2.25	2.50	2.75	3.38	.70	.78	.95	1.50
1-1/2x1			2.18	2.50	2.75	3.25	.62	.75	.80	1.50
1-1/2x3/4			2.13	2.50	2.75	3.13	.54	.70	.75	1.38
1-1/2x1/2			2.00	2.50	2.75	3.00	.50	.65	.73	1.25
2x1-1/2	1.30	1.80	3.75	4.25	5.50	6.00	.90	1.20	1.60	2.38
2x1-1/4	1.20	1.65	3.60	4.13	5.25	5.75	.84	1.15	1.50	2.25
2x1	1.10	1.50	3.50	4.10	5.13	5.38	.76	1.10	1.50	2.15
2x3/4			3.25	4.00	5.00	5.13	.70	1.00	1.45	2.00
2-1/2x2	2.45	3.25	6.00	7.19	7.00	9.50	1.50	2.00	2.50	4.00
2-1/2x1-1/2	2.20	2.90	5.50	7.13	6.88	9.25	1.38	1.90	2.25	3.90
2-1/2x1-1/4	2.10	2.75	5.25	7.06	6.75	8.75	1.25	1.85	2.25	3.60
2-1/2x1			5.00	7.00	6.50	8.50	1.25	1.75	2.20	3.50
3x2-1/2	4.15	5.50	6.75	8.25	9.50	13.00	2.00	2.75	3.70	6.00
3x2	3.50	4.70	6.50	8.00	9.25	12.75	1.80	2.60	3.40	5.00
3x1-1/2	3.20	4.30	6.25	7.50	9.15	12.50	1.70	2.50	3.20	4.90
3x1-1/4			6.15	7.60	9.25	12.00	1.60	2.40	3.10	4.75
3-1/2x3	6.00	8.20	8.80	12.60		16.00	3.15	4.00		8.00
3-1/2x2-1/2	5.40	7.25	8.50	12.20		15.50	2.88	3.50		8.00
3-1/2x2	4.50	6.30	8.30	11.80		15.00	2.75	3.50		7.00
3-1/2x1-1/2			8.00	11.50		14.00	2.50	3.25		7.00
3-1/2x1-1/4							2.40	3.25		7.00
4x3-1/2	8.20	11.30	11.80	15.60		24.00	3.50	4.75		9.00
4x3	7.50	10.40	11.60	15.25	21.00	23.25	3.38	4.50	6.40	9.00
4x2-1/2	10.50	9.30	11.30	15.00	20.75	22.50	3.25	4.38	5.50	8.50
4x2	5.95	8.25	11.15	15.50	20.50	21.50	3.00	4.25	5.40	8.25
4x1-1/2			11.25	15.25	20.00	20.00	2.88	4.00	5.25	8.00
5x4	13.10	18.40	21.00	25.50	37.00	38.00	6.00	8.25	12.50	16.00
5x3-1/2	12.20	17.10	20.50	25.00		37.00	5.75	7.75		15.00
5x3	11.40	16.00	20.00	24.50	36.00	36.00	5.50	7.50	11.00	14.50
5x2-1/2	10.50	14.70	19.50	24.00	35.00	35.00	5.25	7.00	10.50	13.75
5x2			19.00	23.50	34.00	34.00	5.00	6.50	10.00	14.00
6x5	20.75	30.50	34.50	40.00	61.00	58.00	8.50	12.00	18.75	23.00
6x4	18.40	26.90	33.50	39.25	60.00	57.00	8.25	11.50	16.50	22.00
6x3-1/2	17.35	25.40	33.00	38.25		56.00	8.25	11.00		21.00
6x3	16.40	24.00	32.50	37.00	58.00	55.00	8.00	10.50	15.50	20.00
6x2-1/2			32.00	36.00	57.00	54.00	7.25	10.00	15.00	19.00

Student Supplement 10
Courtesy of The Ladish Company

BUTT WELDING FITTINGS

APPROXIMATE WEIGHT (LBS.)

Nom Pipe Size	90° L R Reducing Elbows		Reducing Outlet Tees				Concentric & Eccentric Reducers			
	STD	XS	STD	XS	SCH 160	XXS	STD	XS	SCH 160	XXS
8x6	39 20	59 40	54 00	74 00	108	118	13 25	18 75	31 00	36 00
8x5	35 50	52 90	53 00	73 00	106	116	12 00	18 00	27 25	35 00
8x4	32 40	48 20	51 75	71 75	102	114	11 00	17 00	23 50	33 00
8x3-1/2			50 75	70 75		113	11 00	16 50		32 00
10x8	71 20	101 25	84 50	109	250		22 00	29 50	57 50	
10x6	61 25	85 80	83 00	108	240		21 50	29 50	54 00	
10x5	56 75	77 75	81 00	106	220		21 00	28 00	52 00	
10x4			80 00	104	200		20 00	25 50	50 00	
12x10	111 50	149 10	119	184	365		34 00	43 50	96 00	
12x8	96 50	134 70	117	175	350		32 00	42 00	87 00	
12x6	84 75	116 00	114	165	330		31 00	40 00	83 00	
12x5			110	160	320		30 00	39 00	80 00	

Nom Pipe Size	Reducing Outlet Tees		Concentric & Eccentric Reducers	
	STD	XS	STD	XS
14x12	160	237	60 00	80 00
14x10	158	233	59 25	79 25
14x8	155	225	58 50	78 50
14x6	115	218	58 00	78 00
16x14	194	275	71 00	91 00
16x12	191	270	70 00	90 00
16x10	186	266	69 50	89 00
16x8	180	260	68 50	88 50
16x6	173	255		
18x16	241	321	85 00	115
18x14	236	315	84 00	114
18x12	230	307	83 00	113
18x10	222	296	82 00	112
18x6	211	281		
20x18	340	477	125	170
20x16	338	475	124	169
20x14	336	472	122	168
20x12	334	469	120	167
20x10	332	466		
20x8	330	463		
22x20	412	547	142	186
22x18	410	544	138	182
22x16	408	541	131	173
22x14	406	538	123	163
22x12	404	535		
22x10	402	532		

Nom Pipe Size	Reducing Outlet Tees		Concentric & Eccentric Reducers	
	STD	XS	STD	XS
24x22	525	607		
24x20	522	604	150	200
24x18	519	601	148	195
24x16	516	598	145	190
24x14	513	595		
24x12	510	592		
24x10	507	589		
26x24	760	865	207	276
26x22	755	860	200	272
26x20	750	850	190	253
26x18	745	845	182	242
26x16	740	840		
26x14	735	835		
26x12	730	830		
28x26			224	299
28x24			216	288
28x22			210	250
28x20			199	264
30x28			241	322
30x26	1045	1180	232	310
30x24	1035	1170	224	299
30x22	1025	1160	220	285
30x20	1015	1150	220	274
30x18	1005	1140		
30x16	995	1130		

For unlisted sizes, weights available on request

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 11—Forged Steel Threaded Fittings

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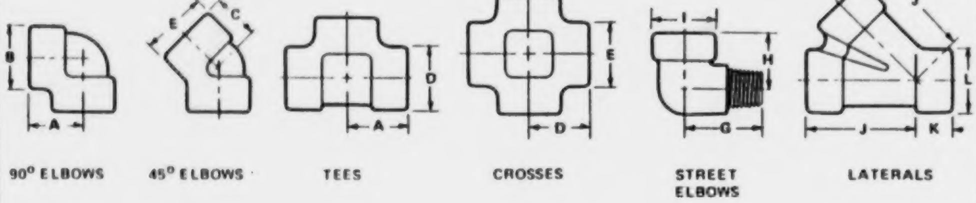
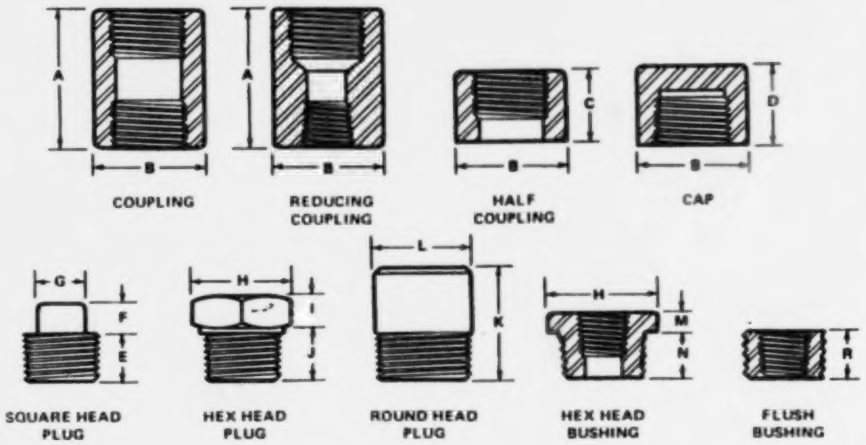


Pressure Class	Nom. Pipe Size	Elbows, Tees and Crosses A	B	C	D	E	Street Elbows G	H	I	Laterals J	K	L
2000	1/8	.81	.88	.69	.81	.94						
	1/4	.81	.88	.69	.81	.94				1.66	.72	.94
	3/8	.97	1.00	.75	.97	1.06				1.91	.84	1.00
	1/2	1.12	1.31	.88	1.12	1.31				2.16	.91	1.25
	3/4	1.31	1.50	1.00	1.31	1.50				2.59	1.03	1.50
	1	1.50	1.81	1.12	1.50	1.81				3.03	1.16	1.81
	1-1/4	1.75	2.19	1.31	1.75	2.25				3.56	1.38	2.25
	1-1/2	2.00	2.44	1.34	2.00	2.50				4.00	1.50	2.50
	2	2.38	2.97	1.69	2.38	3.06				4.81	1.75	3.06
	2-1/2	3.00	3.62	2.06	3.25	4.00				6.88	2.12	3.62
	3	3.38	4.31	2.50	3.38	4.62				7.00	2.12	4.06
	4	4.19	5.75	3.12	4.19	5.75				8.50	2.50	5.12
3000	1/8	.81	.88	.69	.81	.94	1.25	.88	1.06			
	1/4	.97	1.00	.75	.97	1.06	1.25	.88	1.06	1.91	.84	1.00
	3/8	1.12	1.31	.88	1.12	1.31	1.50	1.00	1.25	2.16	.91	1.25
	1/2	1.31	1.50	1.00	1.31	1.50	1.62	1.12	1.50	2.59	1.03	1.50
	3/4	1.50	1.81	1.12	1.50	1.81	1.88	1.38	1.75	3.03	1.16	1.81
	1	1.75	2.19	1.31	1.75	2.25	2.25	1.75	2.00	3.56	1.38	2.25
	1-1/4	2.00	2.44	1.34	2.00	2.50	2.62	2.00	2.44	4.00	1.50	2.50
	1-1/2	2.38	2.97	1.69	2.38	3.06	2.81	2.12	2.75	4.81	1.75	3.06
	2	2.50	3.31	1.72	2.50	3.31*	3.31	2.50	3.31	6.88	2.12	3.62
	2-1/2	3.25	4.00	2.06	3.25	4.00				7.00	2.12	4.06
	3	3.75	4.75	2.50	3.38	4.62				8.50	2.50	5.12
	4	4.50	6.00	3.12	4.19	5.75				13.62	4.00	6.75
6000	1/8	.97	1.00	.75	.97	1.06						
	1/4	1.12	1.31	.88	1.12	1.31	1.50	1.00	1.25			
	3/8	1.31	1.50	1.00	1.31	1.50	1.62	1.12	1.50	2.59	1.03	1.50
	1/2	1.50	1.81	1.12	1.50	1.81	1.88	1.38	1.75	3.03	1.16	1.81
	3/4	1.75	2.19	1.31	1.75	2.25	2.25	1.75	2.00	3.56	1.38	2.25
	1	2.00	2.44	1.34	2.00	2.50	2.62	2.00	2.43	4.00	1.50	2.50
	1-1/4	2.38	2.97	1.69	2.38	3.06	2.81	2.12	2.75	4.81	1.75	3.06
	1-1/2	2.50	3.31	1.72	2.50	3.31*	3.31	2.50	3.31	6.88	2.12	3.62
	2	3.25	4.00	2.06	3.25	4.00				7.00	2.12	4.06
	2-1/2	3.75	4.75	2.50	3.38	4.75				8.50	2.50	5.12
	3	4.19	5.75	3.12	4.19	5.75				8.50	2.50	5.12
	4	4.50	6.00	3.12	4.50	6.00				8.50	2.50	5.12

All dimensions given in inches
Dimensions and tolerances in accordance with ANSI B16.11 which does not include street elbows and laterals
Class 2000 fittings rated same as Sch 80 threaded pipe
Class 3000 fittings rated same as Sch 160 threaded pipe
Class 6000 fittings rated same as double extra strong threaded pipe

Student Supplement 11
Courtesy of The Ladish Company



Pressure Class	Nom. Pipe Size	Couplings and Caps				Plugs and Bushings										
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	R
3000	1/8	1.25	.75	.62	.75	.31	.25	.28	.44	.19	.38	1.38	.44			
	1/4	1.38	.75	.69	1.00	.50	.25	.38	.62	.19	.50	1.62	.56	.12	.50	.44
	3/8	1.50	.88	.75	1.00	.50	.31	.44	.69	.25	.56	1.62	.69	.31	.56	.50
	1/2	1.88	1.12	.94	1.25	.69	.38	.56	.88	.31	.69	1.75	.84	.31	.69	.56
	3/4	2.00	1.38	1.00	1.44	.69	.44	.62	1.06	.38	.75	1.75	1.06	.25	.75	.62
	1	2.38	1.75	1.19	1.62	.75	.62	.81	1.38	.38	.81	2.00	1.31	.25	.81	.75
	1-1/4	2.62	2.25	1.31	1.94	.81	.69	.94	1.75	.56	.88	2.00	1.69	.38	.88	.81
	1-1/2	3.12	2.50	1.56	1.94	.81	.75	1.12	2.00	.62	1.00	2.00	2.00	.38	.94	.81
	2	3.38	3.00	1.69	2.06	.88	.81	1.31	2.50	.69	1.00	2.50	2.50	.44	1.00	.88
	2-1/2	3.62	3.62	1.81	2.38	1.06	.94	1.50	3.00	.75	1.31	2.75	3.00	.50	1.31	1.06
	3	4.25	4.25	2.12	2.56	1.12	1.00	1.69	3.50	.81	1.38	2.75	3.62	.50	1.25	1.12
	4	4.75	5.50	2.38	2.69	1.50	1.25	2.50	4.62	1.25	1.50	3.00	4.62	.62	1.50	1.25
6000	1/8	1.25	.88	.62	.88											
	1/4	1.38	1.00	.69	1.06											
	3/8	1.50	1.25	.75	1.06											
	1/2	1.88	1.50	.94	1.31											
	3/4	2.00	1.75	1.00	1.50											
	1	2.38	2.25	1.19	1.69											
	1-1/4	2.62	2.50	1.31	2.00											
	1-1/2	3.12	3.00	1.56	2.06											
	2	3.38	3.62	1.69	2.19											
	2-1/2	3.62	4.25	1.81	2.75											
	3	4.25	5.00	2.12	2.94											
	4	4.75	6.25	2.38	3.25											

NOTE

Threaded plugs and bushings are not rated and can be used through Class 6000. Threaded couplings, reducing couplings, half couplings and caps are manufactured in Class 3000 and 6000 only. Ladish forged fittings can be furnished to dimensions given in alloy, stainless steel and other metals. Reducing fittings can be furnished by machining straight size blanks or by use of straight fittings and flush bushings.

All dimensions given in inches
Dimensions and tolerances in accordance with ANSI B16.11
Class 3000 fittings rated same as Sch. 160 threaded pipe
Class 6000 fittings rated same as double extra strong threaded pipe

Student Supplement 11
Courtesy of The Ladish Company

APPROXIMATE WEIGHT (LBS.)

Pressure Class	Nom. Pipe Size	90° Elbows	45° Elbows	Tees	Crosses	Laterals	Street Elbows	Couplings	Reducing Couplings	Half Couplings	Caps
2000	1/8	.25	.13	.25	.50						
	1/4	.25	.13	.25	.50	.25					
	3/8	.31	.25	.31	.50	.63					
	1/2	.56	.44	.56	.88	1.00					
	3/4	.69	.63	.94	1.13	1.75					
	1	1.13	.94	1.44	1.69	2.38					
	1-1/4	1.69	1.38	2.00	2.50	3.00					
	1-1/2	2.25	1.63	2.75	3.19	4.13					
	2	3.50	2.69	4.63	5.25	6.63					
	2-1/2	6.50	7.75	8.69	16.44	25.00					
	3	10.50	11.31	13.19	19.50	25.00					
	4	22.75	19.13	27.25	32.69	35.00					
3000	1/8	.25	.25	.25	.44		.25	.13		.07	.03
	1/4	.38	.25	.38	.38	.63	.25	.13	.13	.07	.06
	3/8	.63	.50	.81	1.00	1.31	.38	.25	.25	.19	.13
	1/2	1.31	.75	1.19	1.50	1.75	.50	.25	.25	.19	.25
	3/4	1.38	1.19	1.88	2.50	2.75	.88	.44	.44	.25	.31
	1	2.25	1.88	2.50	3.56	4.68	1.44	.63	.63	.31	.50
	1-1/4	2.75	2.13	3.13	4.13	5.50	2.25	1.56	1.56	.75	1.00
	1-1/2	3.50	3.00	5.00	6.50	10.81	3.00	2.19	2.19	1.13	1.63
	2	5.44	4.25	6.75	8.13	35.00	5.19	3.13	3.13	1.56	3.13
	2-1/2	10.69	7.38	13.13	16.75	40.00		4.00	4.00	2.00	5.00
	3	14.44	10.50	20.38	19.75	75.00		6.75	6.75	3.38	8.50
	4	30.38	19.06	39.50	32.00	240.00		16.75	16.75	8.38	14.00
6000	1/8	.25	.25	.50	.56			.19		.09	.06
	1/4	.63	.50	1.00	1.19		.38	.19	.19	.09	.13
	3/8	1.06	.50	1.38	1.50	2.33	.44	.25	.25	.13	.25
	1/2	1.63	1.44	2.13	2.75	3.25	1.00	.50	.50	.25	.31
	3/4	2.63	2.19	3.63	4.31	5.44	1.63	1.00	1.00	.50	.50
	1	3.50	2.69	4.63	5.63	7.19	2.50	2.13	2.13	1.06	1.05
	1-1/4	6.75	4.69	7.63	10.75	12.31	3.69	2.38	2.38	1.19	1.65
	1-1/2	7.50	5.75	9.63	11.50	40.00	6.44	4.38	4.38	2.19	3.13
	2	13.44	9.50	18.88	22.19	50.00		7.75	7.75	3.88	5.00
	2-1/2	20.88	15.00	28.06	27.50	90.00		10.75	10.75	5.38	8.50
	3	34.56	30.56	45.63	54.00	75.00		13.50	13.50	6.75	14.00
	4							24.50	24.50	12.25	23.00

Nom. Pipe Size	Sq. Hd. Plug	Hex Hd. Plug	Round Hd. Plug	Hex Bushing	Flush Bushing
1/8	.02	.06	.13		
1/4	.03	.06	.13	.06	.06
3/8	.06	.13	.19	.06	.06
1/2	.13	.19	.25	.06	.06
3/4	.19	.31	.38	.13	.13
1	.31	.50	.75	.19	.13
1-1/4	.56	1.13	1.13	.38	.13
1-1/2	.88	1.38	1.56	.69	.19
2	1.50	2.25	3.00	1.63	.38
2-1/2	2.25	3.88	4.75	2.38	.63
3	2.88	5.88	7.63	3.50	1.00
4	7.19	13.00	12.88	8.31	2.00

Introduction to Pipe Drafting With CAD
Unit 1

Student Supplement 12—Forged Steel Socket Welding Fittings
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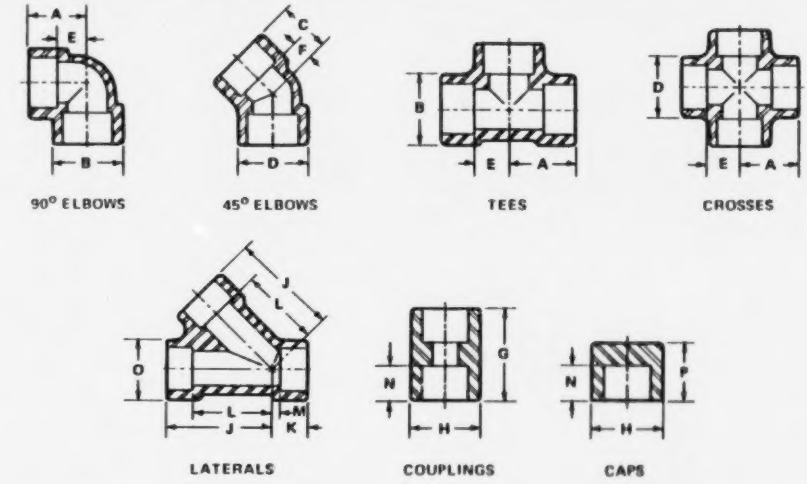


Common Dimensions			Elbows, Tees and Crosses						Laterals, Couplings and Caps								
Nom. Pipe Size	Min. Socket Dia.	Nom. Bore Dia.	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
							PRESSURE CLASS 3000										
1/8	.420	.269	.81	.94	.69	.94	.44	.31	1.12	.75					.44		.69
1/4	.555	.364	.81	.94	.69	.94	.44	.31	1.12	.88	1.62	.69	1.25	.31	.44	.94	.75
3/8	.690	.493	.94	1.06	.72	1.06	.53	.31	1.12	1.12	1.88	.81	1.44	.38	.44	1.25	.75
1/2	.855	.622	1.06	1.31	.84	1.31	.62	.44	1.25	1.25	2.06	.81	1.62	.38	.44	1.25	.81
3/4	1.065	.824	1.28	1.50	1.00	1.53	.75	.50	1.50	1.50	2.53	.97	2.00	.44	.56	1.50	1.00
1	1.330	1.049	1.44	1.84	1.09	1.81	.88	.56	1.62	1.88	2.94	1.06	2.38	.50	.56	1.81	1.00
1-1/4	1.675	1.380	1.69	2.25	1.22	2.25	1.06	.69	1.62	2.25	3.44	1.25	2.81	.62	.56	2.25	1.06
1-1/2	1.915	1.610	1.94	2.50	1.31	2.50	1.25	.81	1.62	2.50	3.88	1.38	3.19	.69	.56	2.50	1.06
2	2.406	2.067	2.31	3.06	1.69	3.06	1.50	1.00	2.12	3.00	4.69	1.62	3.88	.81	.69	3.06	1.31
2-1/2	2.906	2.469	2.94	3.62	2.00	4.00	1.62	1.12	2.12	3.62	6.88	2.12	5.94	1.19	.69	3.62	1.31
3	3.535	3.068	3.31	4.31	2.44	4.62	2.25	1.25	2.12	4.38	8.50	2.50	7.25	1.25	.69	5.12	1.44
4	4.545	4.026	4.19	5.75	3.12	5.75	2.62	1.62	2.88	5.50	13.62	4.00	12.12	2.50	.81	6.75	1.56
							PRESSURE CLASS 6000										
3/8	.690	.344	1.12	1.31	.88	1.31	.62	.44	1.12	1.31	2.12	.88	1.50	.25	.44	1.25	.94
1/2	.855	.464	1.28	1.50	.97	1.53	.75	.50	1.25	1.50	2.56	1.00	2.00	.44	.44	1.50	.94
3/4	1.065	.612	1.47	1.84	1.09	1.81	.88	.56	1.50	1.75	3.00	1.12	2.38	.50	.56	1.81	1.06
1	1.330	.815	1.72	2.25	1.28	2.25	1.06	.69	1.62	2.25	3.50	1.31	2.81	.62	.56	2.25	1.19
1-1/4	1.675	1.160	1.97	2.50	1.31	2.50	1.25	.81	1.62	2.50	3.94	1.44	3.19	.69	.56	2.50	1.19
1-1/2	1.915	1.338	2.34	3.06	1.66	3.06	1.50	1.00	1.62	3.00	4.75	1.69	3.88	.81	.56	3.06	1.31
2	2.406	1.687	2.47	3.38	1.75	3.38	1.62	1.12	2.12	3.62	6.88	2.12	6.00	1.25	.69	3.62	1.44
2-1/2	2.906	2.125	3.19	4.00	2.00	4.00	2.25	1.25	2.12	4.25	8.50	2.50	7.50	1.50	.69	5.12	1.44
3	3.535	2.624	3.69	4.75	2.44	4.62	2.50	1.38	2.12	5.00	8.50	2.50	7.25	1.25	.69	5.12	1.56
4	4.545	3.438	4.50	6.00	3.12	5.75	2.62	1.62	2.38	6.25	13.62	4.00	12.12	2.50	.81	6.75	1.81

All dimensions given in inches.
Dimensions and tolerances in accordance with ANSI B16.11
Class 3000 fittings rated same as Sch. 80.
Class 6000 fittings rated same as Sch. 160 pipe.
Class 6000 socket fitting sizes NPS 2-1/2 and larger not included in ANSI B16.11

Student Supplement 12
Courtesy of The Ladish Company

APPROXIMATE WEIGHT (LBS.)

Pressure Class	Nom. Pipe Size	90° Elbows	45° Elbows	Tees	Crosses	Laterals	Couplings	Caps
3000	1/8	.13	.13	.25	.31		.13	.13
	1/4	.13	.13	.25	.31	.25	.13	.13
	3/8	.25	.19	.31	.31	.63	.19	.19
	1/2	.50	.44	.69	.81	1.00	.25	.25
	3/4	.69	.50	.88	1.13	1.75	.38	.38
	1	1.06	.88	1.44	1.56	2.38	.75	.44
	1-1/4	1.63	1.31	2.13	2.44	3.75	1.13	.94
	1-1/2	2.13	1.75	2.44	3.25	5.00	1.31	1.19
	2	3.56	2.88	4.44	5.50	7.75	2.00	2.00
	2-1/2	6.38	7.38	8.88	15.81	27.00	3.25	3.00
	3	10.88	11.50	13.69	20.19	77.00	4.56	4.63
	4	23.69	19.75	28.44	31.50	260.00	8.63	8.50
6000	3/8	.50	.56	1.00	1.00	1.44	.38	.38
	1/2	.88	.69	1.06	1.25	2.50	.50	.38
	3/4	1.44	1.31	2.06	2.50	3.25	.75	.63
	1	2.50	2.00	3.38	4.00	5.38	1.56	1.19
	1-1/4	3.25	2.63	4.31	5.13	6.75	1.81	1.38
	1-1/2	5.21	4.75	7.81	9.00	12.81	3.00	2.25
	2	6.38	5.88	8.69	9.50	38.00	4.75	2.88
	2-1/2	12.00	7.13	16.63	19.88	97.00	6.31	6.38
	3	19.75	12.31	23.81	29.50	85.00	9.00	7.94
	4	36.38	27.00	45.19	41.50	282.00	15.63	13.25

Introduction to Pipe Drafting With CAD
Unit 1

Assignment Sheet 1—Practice Vertical, Inclined, and CAD Lettering

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Vertical letters and numerals construction	______
Inclined letters and numerals construction	______
Proper color, font, and layer assignment	______

Directions: Letter the following exercises using the given notes. Tape this assignment sheet to a drawing surface and construct light guidelines. Draw inclined guidelines for inclined lettering to maintain slope uniformity. REVIEW "Lettering," Unit VII of MAVCC's *Basic Drafting.*

Problem 1: Construct ⅛" vertical Gothic letters and numerals.

1½" 150# THREADED CPLG (TYP 3 PL)

BOP EL 114'-6¾"

MATCH LINE SEE DWG NO 133

E 5125'-0" E-140 A & B

STABILIZER

NOTE:

1. THIS SKID IS DRAWN SHOWING
UNION HDL 12" × 14" × 19"
PUMP AND IS SUBJECT TO CHECK
ON RECEIPT OF CERTIFIED PRINTS
FROM PURCHASED VENDOR.

Problem 2: Construct ¼" vertical Gothic letters and numerals.

E-30 V-21 P-1 V-41

STABILIZER CRUDE PRODUCT COOLER

STORAGE TANK AFTERCOOLER

Assignment Sheet 1

Problem 3: Construct ⅛" inclined Gothic letters and numerals.

1½" 150# THREADED CPLG (TYP 3 PL)

BOP EL 114'-6¾"

MATCH LINE SEE DWG NO 133

E 5125'-0" E-140 A & B

STABILIZER

TOS 115'-6¼"

EL 128'-8"

NOTE:
1. THIS SKID IS DRAWN SHOWING UNION HDL 12" × 14" × 19" PUMP AND IS SUBJECT TO CHECK ON RECEIPT OF CERTIFIED PRINTS FROM PURCHASED VENDOR.

2. FOR INSULATION REQUIREMENT CONSULT INSULATION SPEC. 8.1.

Problem 4: Construct ¼" inclined Gothic letters and numerals

E-30 V-21 P-1 V-41

PRODUCT COOLER

AFTERCOOLER

ACCESS AREA

Problem 5: Create a layer for lettering and set color and font.

a. Set a new layer called **"Text"** to cyan with a default font of Roman Triplex.

b. Letter the above examples using ⅛" and ¼" text height.

Introduction to Pipe Drafting With CAD
Unit 1

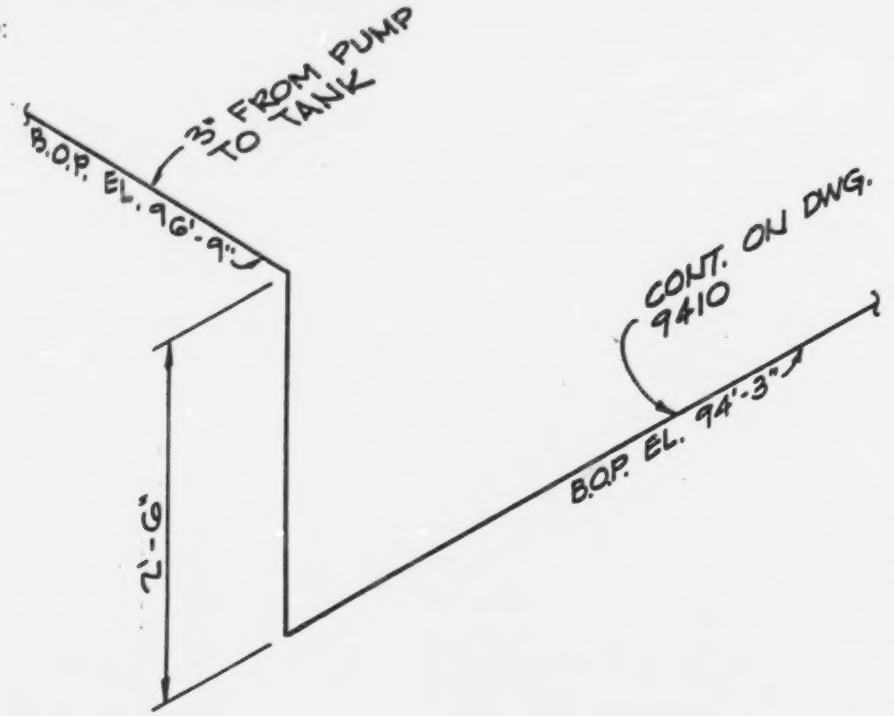
Assignment Sheet 2—Practice Isometric Lettering

Name ______________________________ Overall Rating __________

Evaluation criteria	Rating
⅛" lettering in correct isometric plane	______
¼" lettering in correct isometric plane	______
⅛" and ¼" lettering in correct isometric plane	______

Directions: Draw guidelines parallel to the pipe line, and vertical guidelines to place all dimensions and notes in the same isometric plane. Letter the following exercise on an A size vellum using the example as a guide.

Example:



Assignment Sheet 2

Problem 1: Construct ⅛" isometric Gothic letters and numerals

1½" 150# THREADED CPLG (TYP 3 PL)

BOP EL 114'-6¾"

MATCH LINE SEE DWG NO 133

E 5125'-0" E-140 A & B

STABILIZER

Problem 2: Construct ¼" isometric Gothic letters and numerals

E-30 V-21

STORAGE TANK AFTERCOOLER

Introduction to Pipe Drafting With CAD
Unit 1

Assignment Sheet 3—Measure With Civil Engineer and Architect Scales

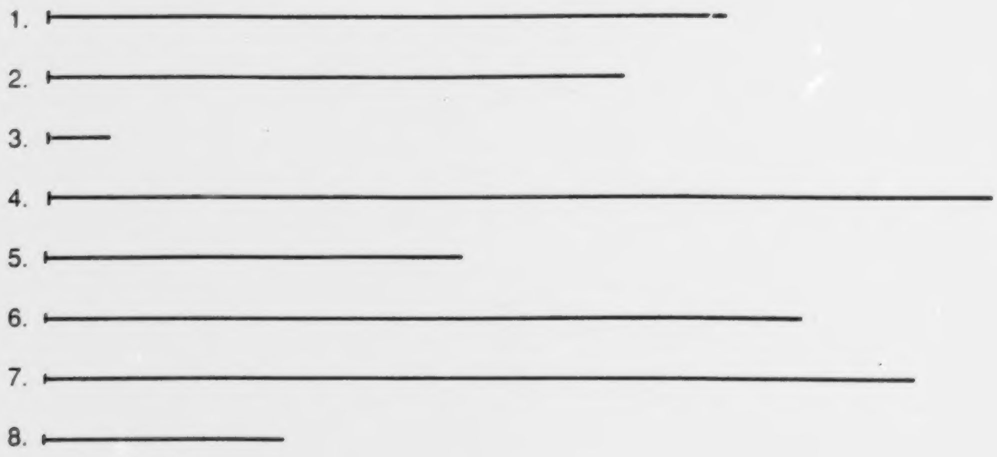
Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Location and use of correct scales	______
Correct sales interpretations	______

Directions: Measure the lines 1 through 8 using each of the scales indicated at the top of each column in the following tables. Place the scale readings in the appropriate spaces in the tables.

Example: Measure line "A" with 3/8" = 1'-0" architect scale. A reading of 10'-4" is obtained. This dimension is placed under the 3/8" = 1'-0" column of the architect scale table.

Problems:



Assignment Sheet 3

	Civil Engineer Scale		Architect Scale			
	1" = 10'-0" nearest 10'	1" = 20'-0" nearest 5'	⅜" = 1'-0" +/- 1"	½" = 1'-0" +/- 1"	1" = 1'-0" +/- ½"	1½" = 1'-0" +/- ¼"
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						

Evaluator's comments: ____________________

____

____

Introduction to Pipe Drafting With CAD
Unit 1

Assignment Sheet 4—Determine Piping Diameter, Weight, and Related Information

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Located appropriate reference material	______
Read and interpreted material correctly	______

Directions: Determine data for the problems given below. Use the following example as a guide for solving the problems. Use available reference material, catalogs, textbooks, notes, and standards catalogs.

Example: Outside diameter of 10″ pipe. Look in reference material for chart showing ANSI standards for steel pipe. Read down the left column listing Nominal pipe size, for 10″. Read across row for column that lists the Outside Diameter. An answer of 10.75″ is obtained.

Problems:

1. Outside diameter for 8″ pipe ______________________________
2. Bolt circle diameter for 10″ 150# steel flange ______________________________
3. Stud bolt length dimension for 8″ 150# steel flange with raised face______________
4. Outside diameter for a 4″ 300# weld neck flange ______________________________
5. Center to face dimension of a radius 6″ 90 welded elbow ______________________
6. Center to face dimension of a short radius 12″ 90 welded elbow ______________
7. Total length of a 6″ welded straight tee ______________________________
8. Total length of a 10″ × 8″ welded concentric reducer ______________________
9. Total length of a 6″ × 4″ welded eccentric reducer ______________________
10. Weight per foot of a 10″ sch 40 pipe ______________________________
11. Weight of a 12″ 400# flanged gate valve ______________________________

Assignment Sheet 4

12. Weight of an 8″ 300# welded swing check valve ____________________
13. The meaning of F to F ____________________
14. The meaning of BOP ____________________
15. The meaning of TOS ____________________
16. The meaning of EL ____________________
17. The meaning of SR ____________________
18. The meaning of LR ____________________
19. The C dim of a 3″ 3000# 45 elbow socket weld fitting ____________________
20. The OD of a 4″ 6000# 90 elbow socket weld fitting ____________________
21. The overall length of a 3″ 6000# coupling socket weld fitting ____________________
22. The center to face dim of a 4″ 3000# cross socket weld fitting ____________________
23. The face to center of a 4″ 3000# screwed 90 elbow ____________________
24. The OD of a 1″ 6000# screwed tee ____________________
25. The overall length of a 2″ 6000# screwed lateral ____________________
26. The weight of a 3″ 6000# screwed tee ____________________
27. The weight per foot of an 8″ sch 140 steel pipe ____________________
28. The wall thickness of a 12″ sch 80 steel pipe ____________________
29. The overall height of a 4″ 3000# cap socket weld fitting ____________________
30. The F to F of a 14″ 300# flanged gate valve ____________________
31. The wheel diameter of a 6″ 600# screwed gate valve ____________________
32. The open dim of a 6″ 400# angle flanged valve ____________________
33. The face to center dim of an 8″ 300# welded angle valve ____________________

Evaluator's comments: ____________________

____

____

Introduction to Pipe Drafting With CAD
Unit 1

Assignment Sheet 5—Calculate Piping Math Problems

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Use of correct reference materials	______
Use of correct formulas	______
Correct answers	______

Directions: Use pipe fitters manuals, textbooks, and other reference materials to help solve the following math problems.

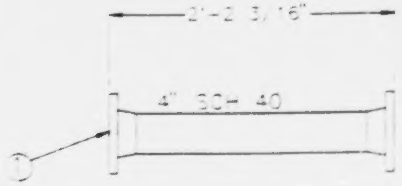
Example: Weight of 10″ sch 40 pipe, 17′-9¼″ long. Use decimal of a foot for inches and fractions and convert 17′-9¼″ to 17.7708′, locate table for dimensions of ANSI standard pipe, determine weight per foot to be 40.5 #'s. Multiply 40.5#s per foot × 17.7798′ = 719.7174#s.

Problems:

1. Weight of 8″ sch 40 pipe, 13′ 5½″ long ______________________
2. Weight of 12″ sch 80 pipe, 3⅞″ long ______________________
3. Weight of 2″ sch 40 pipe, 15′-5¾″ long ______________________
4. Weight of 4″ sch 80 pipe, 9″-3 7/16″ long______________________
5. Weight of 6″ sch 80 pipe, 10′-8¼″ long ______________________

Assignment Sheet 5

Note: Use the following sketch for problems 6 through 10.



① 4" – 150# RFWN (2 REQ'D)

6. What is the length of the pipe? ______

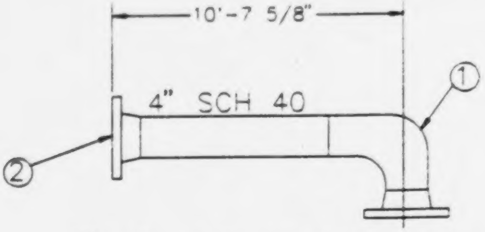
7. What is the length of the pipe, if the overall dim is 17'-6⅞"? ______

8. What is the length of the pipe, if the dia is 8" and the overall dim is 17'-6⅞"? ______

9. What is the weight of the pipe in problem 6? ______

10. What is the weight of the pipe in problem 8? ______

Note: Use the following sketch for problems 11 through 15.



① 4" – STD LR 90° ELBOW
② 4" – 150# RFWN (STD BORE)

11. What is the length of the pipe? ______

12. What is the distance from centerline to face of lower flange? ______

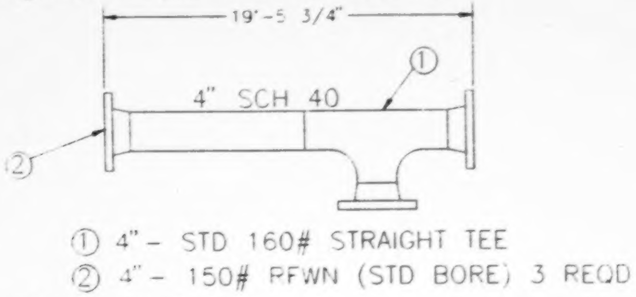
13. What is the length of the pipe if an 8" dia pipe is used? ______

14. What is the length of the pipe if the overall dim is 12'-7¾", a SR 90 ELL is used on 12" sch 40 pipe? ______

15. What is the weight of the pipe in problem 14? ______

Assignment Sheet 5

Note: Use the following sketch for problems 16 through 20.


19'-5 3/4"
①
4" SCH 40
②
① 4" - STD 160# STRAIGHT TEE
② 4" - 150# RFWN (STD BORE) 3 REQD

16. What is the length of the pipe? ______

17. What is the weight of the pipe? ______

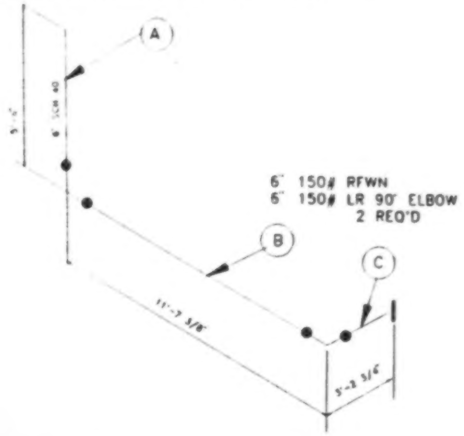
18. What is the total weight of the assembly? ______

19. What is the length of the pipe if an 8" dia is used? ______

20. What is the overall dim from center of pipe to face of the lower RFWN in problem 19?

______

Note: Use the following sketch for problems 21 through 25.


A
6" SCH 40
6" 150# RFWN
6" 150# LR 90° ELBOW
2 REQ'D
B
C
11'-7 3/8"
5'-2 3/8"

21. What is the length of pipe A? ______

22. What is the length of pipe B? ______

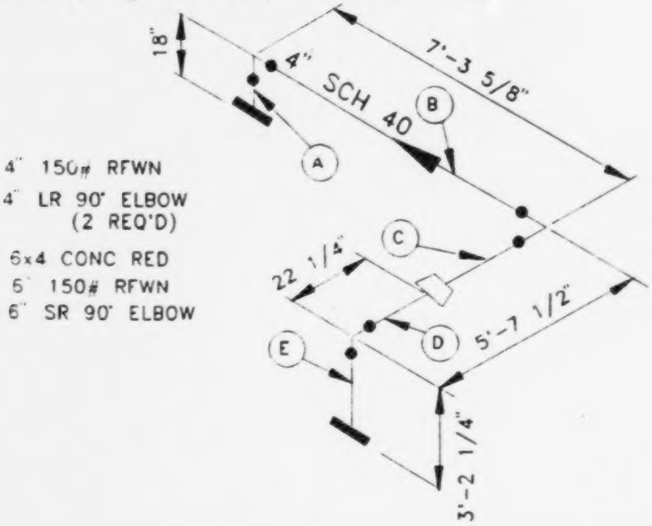
23. What is the length of pie C? ______

24. What is the overall pipe weight (excluding fittings)? ______

25. What is the total weight of the assembly? ______

Assignment Sheet 5

Note: Use the following sketch for problems 26 through 31.


4" 150# RFWN
4" LR 90° ELBOW
(2 REQ'D)
6x4 CONC RED
6" 150# RFWN
6" SR 90° ELBOW
18"
4" SCH 40
7'-3 5/8"
A
B
C
D
E
22 1/4"
5'-7 1/2"
3'-2 1/4"

26. What is the length of pipe A? ______

27. What is the length of pipe B? ______

28. What is the total length of 4′ pipe needed in the assembly? ______

29. What is the length of pipe D? ______

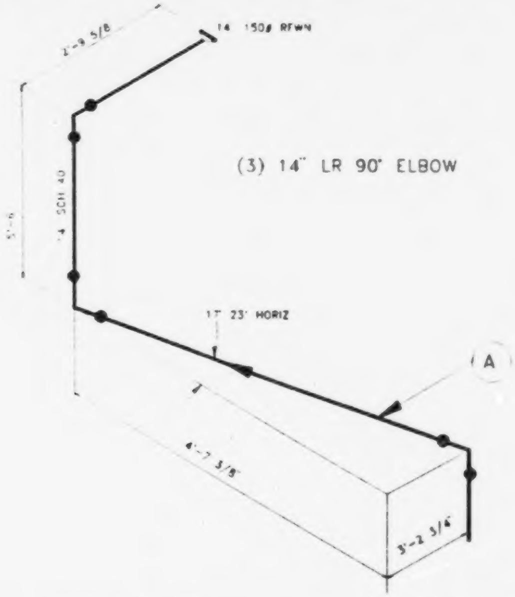
30. What is the total length of 6″ pipe needed in the assembly? ______

31. What is the total weight of the assembly? ______

Assignment Sheet 5

Calculate length of pipe using Trig.

Note: Use the following sketch for problems 32 through 36.


2'-9 5/8
14 150# RFWN
(3) 14" LR 90° ELBOW
5'-6
14 SCH 40
17° 23' HORIZ
A
4'-7 3/8"
3'-2 3/4

32. What is the length of pipe A (don't forget to subtract the fitting dims)? __________

33. Change the 4′-7⅜″ dim to 24′-6⅞″ and calculate the pipe length. __________

34. What is the horizontal angle for problem 41? __________

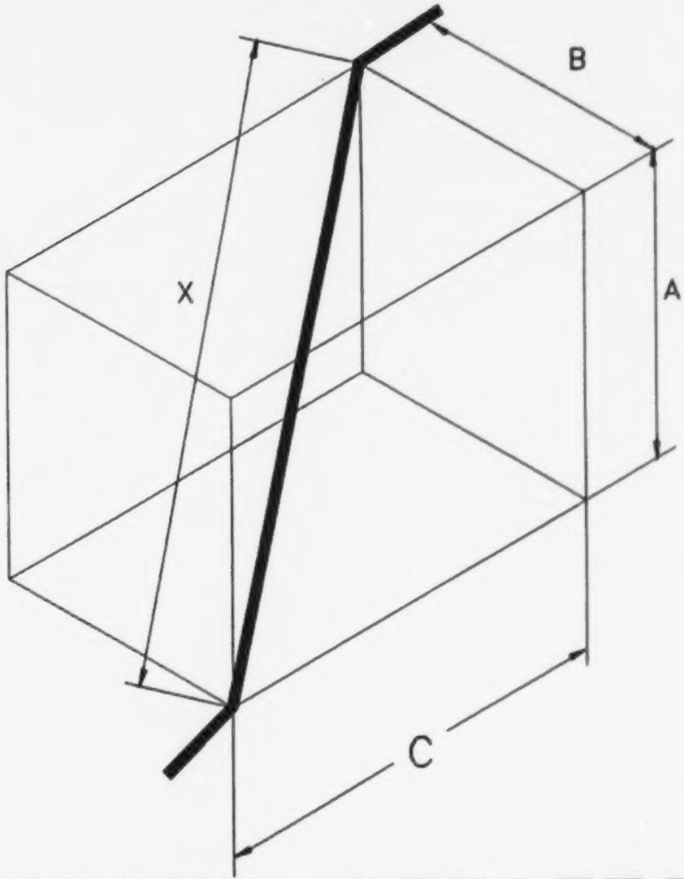
35. Change the 3′-2¾″ dim to 26′-9¼″ and use the 4′-11⅜″ dim and calculate the length of the pipe. __________

36. What is the horizontal angle for problem 35? __________

Assignment Sheet 5

Calculate length of pipe having rolled offsets.

Note: Use the following sketch for problems 37 through 41.



ROLLED OFFSETS

Find dimension "X" if:

37. A = 16′-7⅞″, B = 11′-9¾″, C = 14′-6¼″ – X = ____________________

38. A = 12′-3½″, B = 8′-9⅝″, C = 4′-6⅛″ – X = ____________________

39. A = 2′-10¾″, B = 6′-3¾″, C = 7′-4⅝″ – X = ____________________

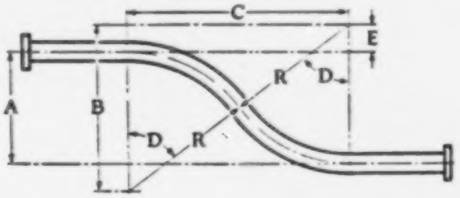
40. A = 5′-1¾″, B = 12′-7½″, C = 9′-4⅞″ – X = ____________________

41. A = 10′-6½″, B = 12′-4⅜″, C = 13′-9½″ – X = ____________________

Assignment Sheet 5

Calculate length of pipe bends.

Note: Use the following sketch for problems 42 through 44.



$$B = 2R - A \qquad C = \sqrt{(2R)^2 - B^2} \qquad \frac{C}{2R} = \sin \angle D$$

Given A and R, calculate B, C, and angle D.

42. A = 6′-7¾″, R = 9′-8¼″

B = ____________ C = ____________ D = ____________

43. A = 13′-3½″, R = 17′-9½″

B = ____________ C = ____________ D = ____________

44. A = 9′-6¾″, R = 21′-5⅜″

B = ____________ C = ____________ D = ____________

Evaluator's comments: ____

____

____

Introduction to Pipe Drafting With CAD
Unit 1

Assignment Sheet 6—Create a Subdirectory on a CAD System

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Equipment and workplace safety	______
Proper start-up and shut-down procedures	______
Use of correct DOS commands	______

Instructions: Using basic DOS commands create a subdirectory below the directory that contains the AutoCAD program. Follow the procedure below:

1. Exit to DOS.
2. Run a directory of the Root Directory DIR
3. Determine which directory contains the AutoCAD program files.

   Note: Check with instructor to be sure.
4. Go to the directory that contains the files. CD______
5. Make a directory called SYM to contain the pipe symbols you will be creating. MD______\\SYM
6. Change to the newly created directory and run a directory.
7. Return to the AutoCAD program and complete Assignment Sheet 7.

Introduction to Pipe Drafting With CAD
Unit 1

Assignment Sheet 7—Draw Piping Symbols on a CAD System

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Proper size of pipe symbols	______
Correct ANSI pipe symbols used	______
Pipe symbols correctly named	______
Pipe symbols correctly stored	______

Instructions: Draw the piping symbols to the appropriate proportion. Name each drawing as indicated and save to ______\SYM directory. Place the dot at coordinate location 0,0. You can scale the given drawings for correct proportions.

1. Bushing
   screwed Name: sbush
   welded Name: wbush

2. Reducing cross
   flanged Name: fredcr
   screwed Name: sredcr
   welded Name: wrdcr

3. Regular cross
   flanged Name: fcr
   screwed Name: scr
   welded Name: wcr

4. 45 degree elbow
   flanged f45el
   screwed s45el
   welded w45el

5. 90 degree elbow
   flanged f90el
   screwed s90el
   welded w90el

Assignment Sheet 7

6.	90 degree elbow turned down	flanged	f90eltd
		screwed	s90eltd
		welded	w90eltd
7.	90 degree elbow turned up	flanged	f90eltu
		screwed	s90eltu
		welded	w90eltu
8.	Pipe joint	flanged	fpj
		screwed	spj
		welded	wpj
9.	Expansion joint	flanged	fej
		screwed	sej
		welded	wej
10.	Lateral	flanged	flat
		screwed	slat
11.	Flanged orifice		forif
12.	Reducing flange		rfl
13.	Concentric reducer	flanged	fconred
		screwed	sconred
		welded	wconred
14.	Eccentric reducer	flanged	feccred
		screwed	seccred
		welded	weccred
15.	Tee	flanged	ftee
		screwed	stee
16.	Reducing tee	flanged	fredtee
		screwed	sredtee
		welded	wredtee
17.	Union	flanged	fun
		screwed	sun
		welded	wun

Assignment Sheet 7

18.	Angled valves	flanged check	fangch
		screwed check	sangch
		welded check	wangch
		flanged gate	fanggate
		screwed gate	sanggate
		welded gate	wanggate
		flanged globe	fangglo
		screwed globe	sangglo
		welded globe	wangglo
19.	Straight valves	flanged check	fchk
		screwed check	schk
		welded check	wchk
		flanged gate	fgate
		screwed gate	sgate
		welded gate	wgate
		flanged globe	fglobe
		screwed globe	sglobe
		welded globe	wglobe
20.	Motor operated valves	flanged gate	fgatem
		screwed gate	sgatem
		welded gate	wgatem
		flanged globe	fglobem
		screwed globe	sglobem
		welded globe	wglobem
21.	Safety valve	flanged	fsafe
		screwed	ssafe
		welded	wsafe
22.	Diaphragm valve	flanged	fdiava
		screwed	sdiava
23.	Float valve	flanged	fflova
		screwed	sflova
		welded	wflova
24.	Pipe Cock	flanged	fpcock
		screwed	spcock
		welded	wpcock

Flow Diagrams
Unit 2

Objective Sheet

Unit Objective

After completing this unit, the student should be able to use a CAD system to draw flow diagram equipment symbols, to draw instrumentation and electrical symbols, and to draw mechanical flow and utility flow diagrams. The student should demonstrate these competencies by completing the assignment sheets and by scoring minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to flow diagrams with their correct definitions.
2. Complete statements about the purposes of piping control systems.
3. Match types of flow diagrams with their applications.
4. Identify common flow diagram piping symbols.
5. Identify common flow diagram equipment symbols.
6. Complete statements about the characteristics of a sheet numbering system.
7. Select true statements about the characteristics of a line numbering system.
8. Complete statements about guidelines for using an equipment numbering system.
9. Select true statements about characteristics of an instrumentation numbering system.
10. Select true statements about guidelines for using a flow transfer numbering system.
11. Match types of control systems with their definitions.

Objective Sheet

12. Arrange in order the steps in operation of a typical level control.
13. Complete statements about guidelines for laying out flow diagrams.
14. Identify parts of line numbers. (Assignment Sheet 1)
15. Draw flow diagram equipment symbols. (Assignment Sheet 2)
16. Draw instrumentation and electrical symbols. (Assignment Sheet 3)
17. Draw a mechanical flow diagram with depropanizers. (Assignment Sheet 4)
18. Draw a mechanical flow diagram with storage facilities. (Assignment Sheet 5)

Flow Diagrams
Unit 2

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan for enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from the transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Process Flow Diagram, Sheet 1 of 5 (Objective 3)
   TM 2—Process Flow Diagram, Sheet 2 of 5 (Objective 3)
   TM 3—Process Flow Diagram, Sheet 3 of 5 (Objective 3)
   TM 4—Process Flow Diagram, Sheet 4 of 5 (Objective 3)
   TM 5—Process Flow Diagram, Sheet 5 of 5 (Objective 3)
   TM 6—Mechanical Flow Diagram (Objective 3)
   TM 7—Utility Flow Diagram (Objective 3)
   TM 8—Process Flow Diagram (Objective 3)
   TM 9—Mechanical Flow Diagram (Objective 3)
   TM 10—Utility Flow Diagram (Objective 3)
   TM 11—Laying out a Flow Diagram (Objective 9)

5. Obtain films, videotapes, and other resources to supplement instruction of this unit. See ordering information in the Suggested Supplemental Resources section that follows.

6. Develop teaching plan. Adjust for different learning styles.

7. Make copies of Unit Evaluation Form.

Delivery and Application

8. Provide students with unit of instruction.

9. Discuss unit and specific objectives.

Suggested Activities

10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignments.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. When teaching Objective 3, note that TMs 1 through 5 can be assembled into one long process flow diagram. Skill areas: **Foundation skills, math**.

2. When reviewing Objective 3, note that TM 4 is the same process flow area as TM 6, and that TM 6 is the same mechanical flow area as TM 7. Skill areas: **Foundation skills, science**.

3. TMs 8, 9, and 10 are of the same plant area that progresses from process to mechanical to utility flow diagrams. Skill areas: **Foundation skills, science**.

4. When teaching Objectives 4, 5, and 6, place emphasis on the fact that these represent company standards, and that all companies have variations in standards. Skill areas: **Foundation skills, reading**.

5. When teaching Objective 9, note that flow diagrams are not drawn to scale, and that laying out the drawing area is extremely important prior to symbol placement. Skill areas: **Adaptability skills, problem solving**.

6. As you monitor student activity on Job Sheets 1 and 2, stress accuracy in drawing as well as accuracy in file storage. Skill areas: **Foundation skills, science**.

Suggested Activities

Resources Used in Developing This Unit

1. *ANSI/ASME Z32.2.3-1949 (R1988), Graphical Symbols for Pipe Fittings, Valves, and Piping.* New York: American National Standards Institute, 1988.

2. *ANSI Y32.11-1961 (R1985), Graphic Symbols for Flow Diagrams in the Petroleum and Chemical Industries.* New York: American National Standards Institute, 1985.

3. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

4. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division, McGraw Hill Book Company, 1981.

5. *Publication AC11RM, AutoCAD Reference Manual.* New York: Autodesk Inc., 1990.

6. Weaver, Rip. *Process Pipe Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Supplemental Resources

1. Weaver, Rip. Video Tape Series, Process Pipe Drafting, Piping Familiarization, Piping Pointers, and Blueprint Reading Basics. Gulf Publishing Company, Book Division, P.O. Box 2608, Houston, TX 77252-2608.

2. Cadpipe Ortho, Iso, P&ID Forms, Software Package, Digitizer Driven. Endeco Engineering Ltd., 200 Carnegie Drive, St. Albert, Alberta T8N 5A7 CANADA. Phone: (403) 459-9041.

3. Pro-Pipe, Software Package, Isometric pipe drafting package. Industrial Graphics, P.O. Box 509, Branch, MI 49402. Phone: (616) 989-2701.

4. Piping Schematic Symbols Library. Drafting Technology Services, 2425 Nowata Place, Suite 202, Bartlesville, OK 74006. Phone (981) 335-2480.

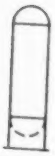
Flow Diagrams
Unit 2

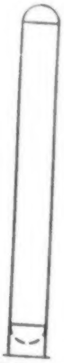
Answers to Assignment Sheets

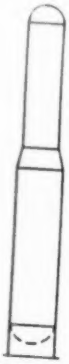
Assignment Sheet 1

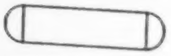
Line number	310	26	192	406
Pressure rating	300#	600#	300#	600#
Material in line	1	1	1	5
Size of line	30″	24″	6″	12″

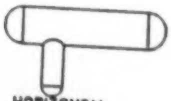
Assignment Sheet 2

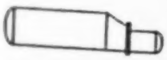
1.

VERTICAL
SCRUBBER
(VSCR)

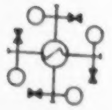
2.

VERTICAL
VESSEL
(VVES)

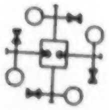
3.

VERTICAL
FRACTIONATOR
(VFRAC)

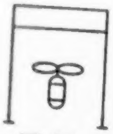
4.

HORIZONTAL
VESSEL
(HV)

5.

HORIZONTAL
VESSEL
WITH SEPERATOR
(HVSEPA)

6.

REBOILER
OR CHILLER
(REBOIL)

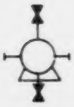
7.

SHELL AND
TUBE HEAT
EXCHANGER
(HESHTU)

8.

FIN TUBE
HEAT
EXCHANGER
(HEFINTU)

9.

AIR FIN
HEAT
EXCHANGER
(HEAIRFIN)

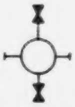
Answers to Assignment Sheets

10.



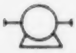
CENTRIFUGAL
PUMP
(PUMPCENT)

11.



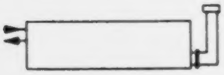
INLINE PUMP
(PUMPINLI

12.



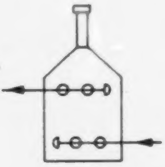
CAN TYPE PUMP
(PUMPCAN)

13.



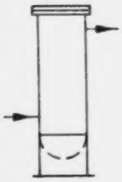
INDIRECT FIRED
HEATER
(HEATIND)

14.



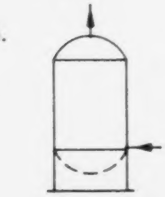
DIRECT FIRED
HEATER
(HEATDIR)

15.



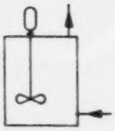
FILTER
(FILT)

16.



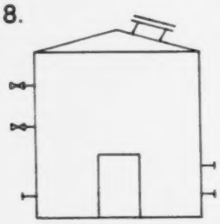
SEA WATER
FILTER
(FILTSEA)

17.



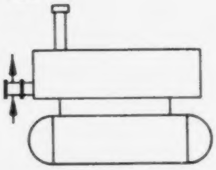
MIX TANK
(MIXTANK)

18.



STORAGE TANK
(ST)

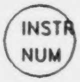
19.



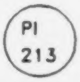
GLYCOL
RECONCENTRATOR
(RECON)

Assignment Sheet 3

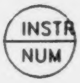
1.



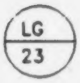
LOCALLY MOUNTED INSTRUMENT
(LTAG)



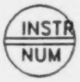
2.



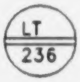
CONTROL ROOM MOUNTED INSTR.
(CTAG)



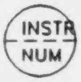
3.



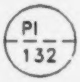
FIELD BOARD MOUNTED INSTR.
(FTAG)



4.

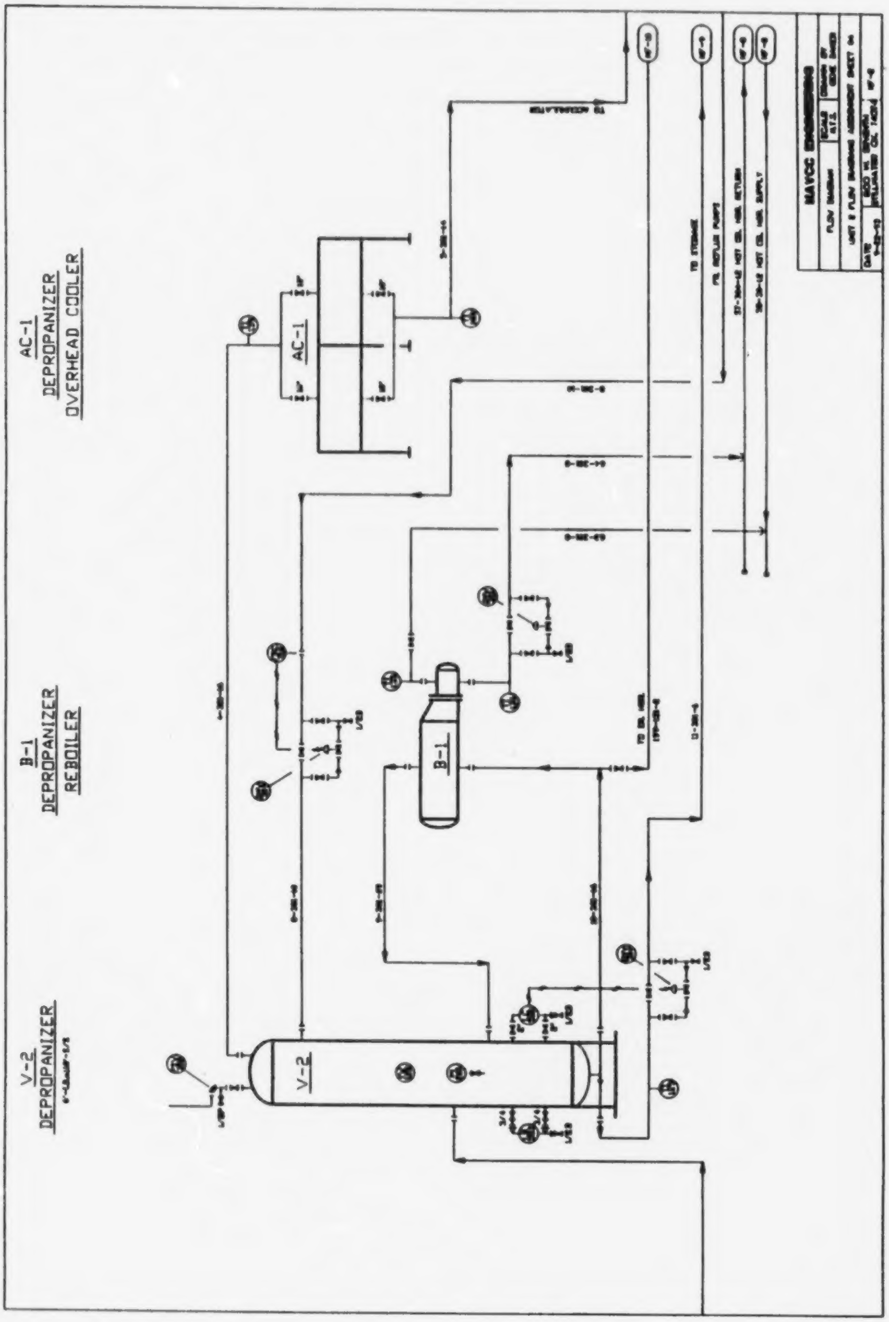


MOUNTED BEHIND BOARD INSTR.
(HTAG)



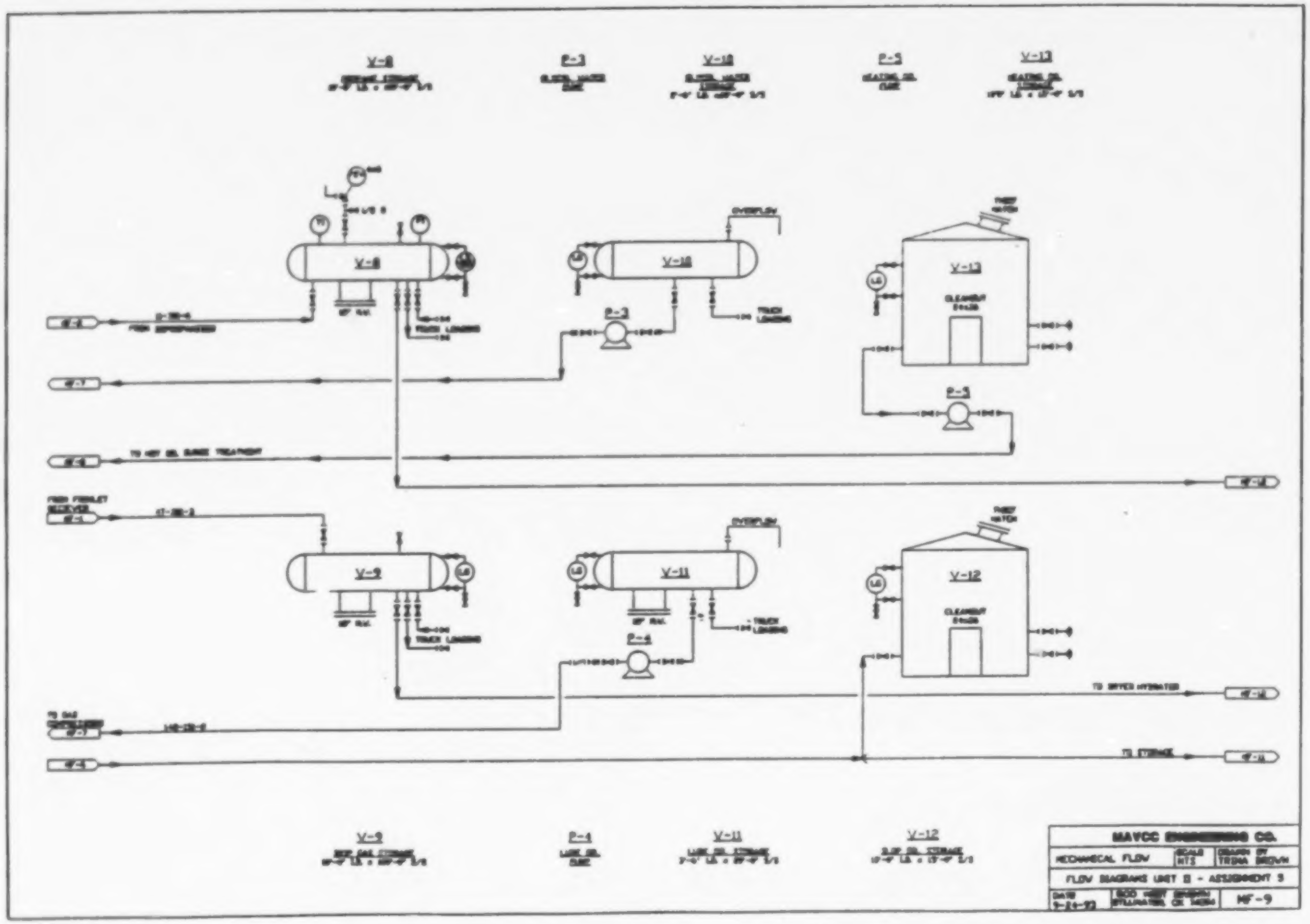
Answers to Assignment Sheets

Assignment Sheet 4


V-2
DEPROPANIZER
B-1
DEPROPANIZER
REBOILER
AC-1
DEPROPANIZER
OVERHEAD COOLER
AC-1
B-1
V-2
TO ACCUMULATOR
TO STORAGE
FR. REFLUX PUMPS
MAVCC ENGINEERING
FLOW DIAGRAM
SCALE
N.T.S.
DATE

Answers to Assignment Sheets

Assignment Sheet 5


V-8
P-3
V-10
P-5
V-13
V-8
V-10
OVERFLOW
V-13
CLEANOUT DOOR
P-3
TRUCK LOADING
TRUCK LOADING
P-5
V-9
V-11
OVERFLOW
V-12
CLEANOUT DOOR
P-4
TRUCK LOADING
TO STORAGE
V-9
P-4
V-11
V-12
MAVCC ENGINEERING CO.
MECHANICAL FLOW
SCALE NTS
DRAWN BY TRINA BROWN
FLOW DIAGRAMS UNIT II - ASSIGNMENT 3
DATE
MF-9

Pipe Drafting With CAD, Unit 2
Teacher Page 8

Flow Diagrams
Unit 2

Answers to Written Test

1. a. 4
   b. 7
   c. 5
   d. 2
   e. 8
   f. 11
   g. 10
   h. 12
   i. 1
   j. 3
   k. 9
   l. 6

2. Answer should equate to the following: To allow the smooth operation of a plant, or to send a signal to an operator if there is a malfunction in plant operations.

3. a. 2
   b. 3
   c. 1

4. a. Flow diagram transfer symbol
   b. Insulation on pipe
   c. Flow direction arrow
   d. Line number break
   e. Line rating change

5. a. Reboiler or chiller
   b. Storage tank
   c. Pump
   d. Horizontal vessel
   e. Filter
   f. Air fin exchanger
   g. Indirect fired heater
   h. Mix tank
   i. Glycol reconcentrator
   j. Vertical vessel
   k. Heat exchanger

6. a. (1) Process Flow
      (2) Mechanical Flow
      (3) Utility Flow
   b. Page, pages
   c. Changes

7. a, b, c

8. a. Letter
   b. Number
   c. Above or below
   d. As close as possible to

Answers to Written Test

9. a, b, c

10. a, b, c, e

11.
    - a. 2
    - b. 4
    - c. 1
    - d. 3

12.
    - a. 4
    - b. 5
    - c. 6
    - d. 1
    - e. 8
    - f. 2
    - g. 3

13.
    - a. Roll
    - b. D
    - c. Are not
    - d. Bottom and top
    - e. Dark, thick
    - f. Horizontal, vertical
    - g. ¼″

Flow Diagrams
Unit 2

Written Test

Name ______________________ Date ______________ Score __________

1. Match the terms on the right with their correct definitions.

_____a. In the direction of the product flow

_____b. Large vessels and implements used in the operation of a plant

_____c. A method of joining pipe components and equipment for later dismantling and maintenance

_____d. A schematic diagram not drawn to scale that shows direction of flow on lines and equipment, indicates size, temperature, pressure, and flow rates

_____e. Oil-free, moisture-free, compressed air system used to operate pneumatic control devices

_____f. Devices used to control and/or indicate temperature, pressure, level, or flow in a pipe or equipment

_____g. Material used on the outside of pipe or equipment to keep temperature constant and to protect personnel

_____h. Moved or worked on by air pressure

_____i. A line drawing which illustrates the arrangement and relationship of components

_____j. A large flat structure that has equipment and controls mounted on it for ease of moving

_____k. In the direction opposite the product flow

_____l. Air used in cleanup operations, in drive motors, and other service functions

1. Schematic diagram
2. Flow diagram
3. Skid
4. Downstream
5. Flange
6. Utility air
7. Equipment
8. Instrument air
9. Upstream
10. Insulation
11. Instrumentation
12. Pneumatic

Written Test

2. Complete statements about the purposes of a piping control system. Circle the material that best completes each of the following statements.

   a. A piping control system permits the (**fast**) (**smooth**) and safe operation of a plant.

   b. A piping control system signals operators when there are (**slow downs**) (**malfunctions**) in plant operations.

   c. A piping control system records valuable operating (**statistics**) (**paramaters**) that require monitoring.

3. Match types of flow diagrams with their application. Put the number of the diagram type in the proper blank.

   ______a. Used by process engineers in designing what major equipment and lines are needed for certain operations in a plant

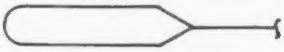
   ______b. Derived from process flow diagrams and used in sizing pipe, system specifications, insulations, line numbers, and instrumentation controls necessary to process a product

   ______c. Derived from mechanical flow diagrams and used to show all other necessary piping, system specifications, and minor equipment needed to process a product

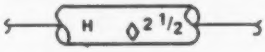
   1. Utility flow
   2. Process flow
   3. Mechanical flow

4. Identify common flow diagram piping symbols. Write the symbol name in the appropriate blank.

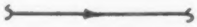
   a. ______________________________



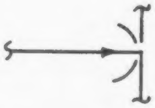
   b. ______________________________



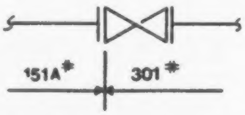
   c. ______________________________



   d. ______________________________



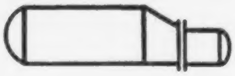
   e. ______________________________



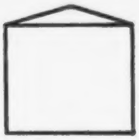
Written Test

5. Identify common flow diagram equipment symbols. Write the symbol name in the appropriate blank.

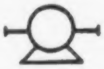
a. ______________________________



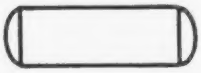
b. ______________________________



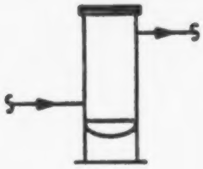
c. ______________________________



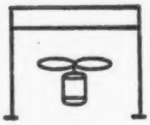
d. ______________________________



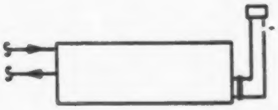
e. ______________________________



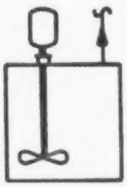
f. ______________________________



g. ______________________________

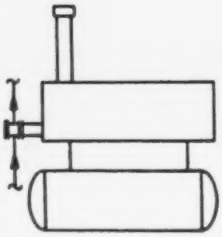


h. ______________________________

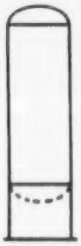


Written Test

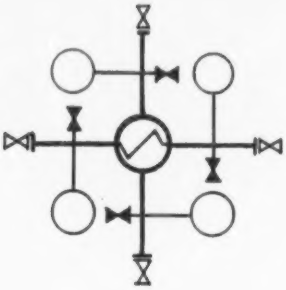
i. ______________________



j. ______________________



k. ______________________



6. Complete statements about the characteristics of a sheet numbering system. Fill in the blanks to correctly complete the following statements.

   a. The first letter in a sheet numbering system indicates the type of flow diagram.

      (1) **P** or **PF** is ____________.

      (2) **M** or **MF** is ____________.

      (3) **U** or **UF** is ____________.

   b. The first number in a sheet numbering system indicates the ____________ number, as in the ____________ of a book.

   c. The second number in a sheet numbering system indicates how many engineering ____________ have been made since the drawing was first approved.

Written Test

7. Select true statements about the characteristics of a line numbering system. Place an "X" beside each true statement.

______a. The first group of numbers in a line numbering system indicates the in-plant line number.

______b. The second group of numbers in a line numbering system indicates the pressure rating of a line.

______c. The third group of numbers in a line numbering system indicates the type of material in the line, and most companies have their own standards.

______d. The fourth group of numbers in a line numbering system indicates the type of the line or pipe.

______e. Line numbers appear on a flow sheet at least one time below the pipe.

8. Complete statements about guidelines for using an equipment numbering system. Circle the material that best completes each of the following statements.

a. Use the first (**letter**) (**number**) in an equipment numbering system to indicate the type of equpment by using the first letter or letters of the equipment name.

b. Use the first (**letter**) (**number**) in an equipment numbering system as the number of the equipment and keep that assigned number consistent on process, mechanical, and utility flow diagrams as well as necessary detail drawings.

c. Place the equipment number and equipment label in the 3 1/2″ margin (**above**) (**above or below**) a vessel as it appears on a flow sheet.

d. Place the equipment number either on the equipment symbol or (**as close as possible to**) (**below**) smaller symbols.

9. Select true statements about characteristics of an instrumentation numbering system. Place an "X" beside each true statement.

______a. The first number in an instrumentation number system indicates the type of instrument.

______b. Additional instrumentation letters are used as needed.

______c. The number in the bottom half of an instrument balloon indicates the instrument number, and that assigned number stays consistent on process, mechanical, and utility flow diagrams as well as necessary detail drawings.

______d. An instrumentation numbering system also includes an isometric number.

Written Test

10. Select true statements about guidelines for using a flow line transfer numbering system. Place an "X" beside each true statement.

______a. Use the flow line transfer numbering system to permit the flow line to be followed from one flow sheet to another by creating balloons.

______b. Place balloons only on lines that end on one sheet and skip one or more sheets before starting again.

______c. Place flow arrows, not balloons, on lines that end on one sheet and start immediately on the next sheet.

______d. Place revision numbers on a transfer balloon if any part of the flow line has been revised.

______e. Place product flow transfer symbols in the upper or lower 3 1/2″ space.

______f. Place utility transfer symbols only to the left of the main drawing.

11. Match types of control systems with their correct definitions. Place the number beside the system type in the appropriate blank.

______a. Controls liquid level in equipment

______b. Controls temperature in a line or equipment

______c. Controls flow rate and amount of liquid or gas in a line

______d. Controls how much pressure is to leave or enter a line, vessel, or tank

1. Flow controller
2. Level controller
3. Pressure controller
4. Temperature controller

Written Test

12. Arrange in order the steps in the operation of a typical level control. Place a "1" beside the first step, a "2" beside the second step, and list other steps in order.

______a. The air supply opens the control valve.

______b. The liquid in the vessel falls to a low liquid level.

______c. The float in the level controller fills to a low position and closes a small valve in the control box.

______d. The cycle starts as liquid rises to a high level.

______e. The air supply is shut off, the control valve closes, and the cycle starts over.

______f. A float in the level controller pushes the actuating rod up.

______g. A small valve in the control box opens to allow air to pass through the control box to the control valve.

13. Complete statements about guidelines for laying out flow diagrams. Circle the material that best completes each of the following statements.

a. Draw process flow diagrams on (**B**) (**C**) (**D**) (**roll**) size paper.

b. Draw mechanical and utility flow diagrams on (**B**) (**C**) (**D**) (**roll**) size paper.

c. Flow diagrams (**are not**) (**are**) drawn to scale.

d. Allow 3½ inches from (**bottom and top**) (**left and right**) border for equipment labels, flow lines, and transfer lines.

e. Show flow lines from equipment with (**dark, thick**) (**dark, thin**) lines.

f. Give (**vertical**) (**horizontal**) lines precedence over (**vertical**) (**horizontal**) lines.

g. Space flow lines at least (¼") (½") apart.

***Permission to duplicate this test is granted.**

Flow Diagrams
Unit 2

Unit Evaluation Form

Student Name ______________________ Unit Rating ________

Assignment Sheet 1—Identify Part and Line Numbers Rating ______

Comments: ______________________________

____

Assignment Sheet 2—Draw Flow Diagram Equipment Symbols Rating ______

Comments: ______________________________

____

Assignment Sheet 3—Draw Instrumentation and Electrical Symbols Rating ______

Comments: ______________________________

____

Assignment Sheet 4—Draw a Mechanical Flow Diagram with Depropanizers Rating ______

Comments: ______________________________

____

Assignment Sheet 5—Draw a Mechanical Flow Diagram with Storage Facilities Rating ______

Comments: ______________________________

____

Unit Evaluation Form

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ____

____

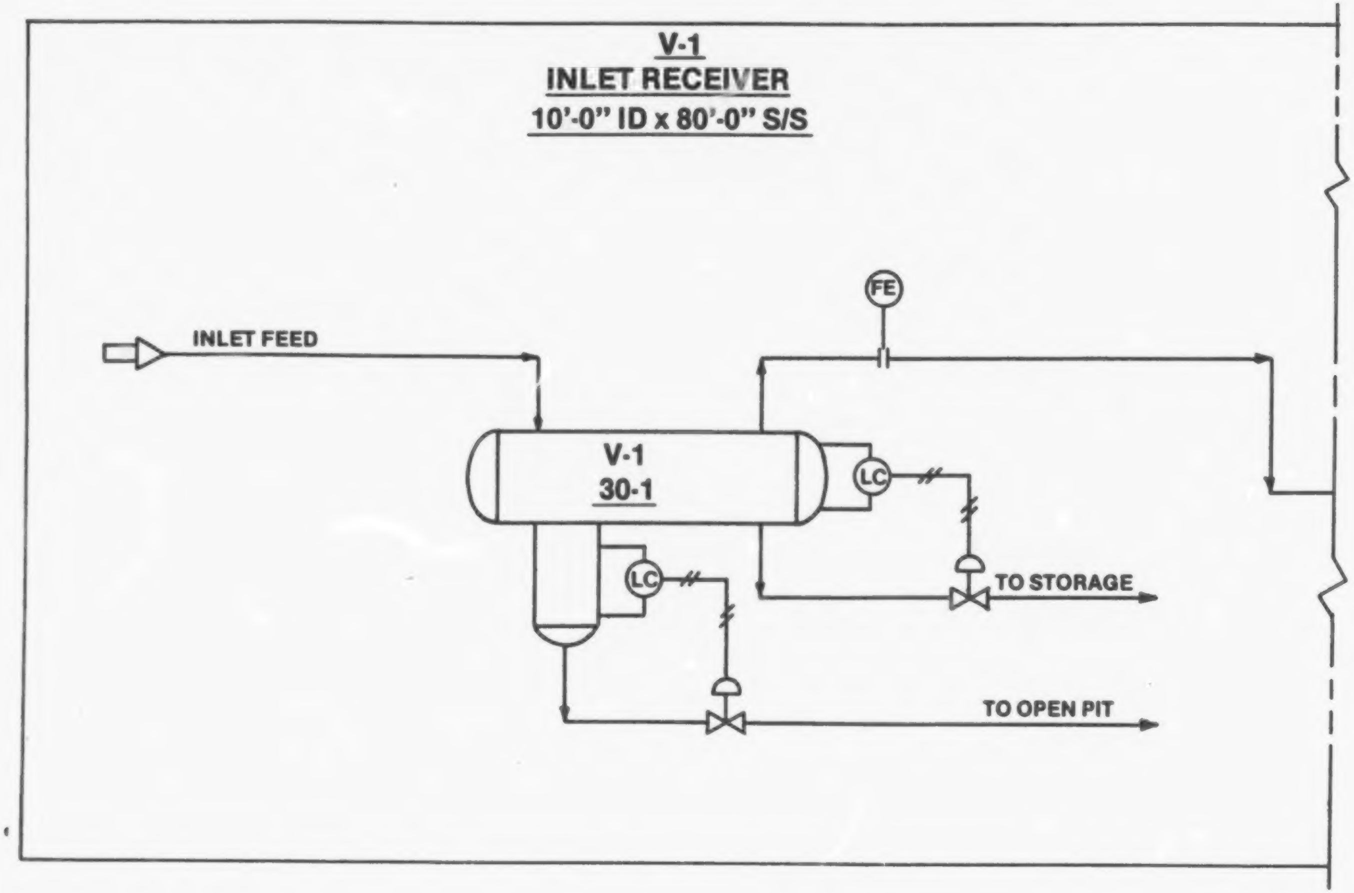
Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

*Permission to duplicate this form is granted.

Process Flow Diagram

Sheet 1 of 5

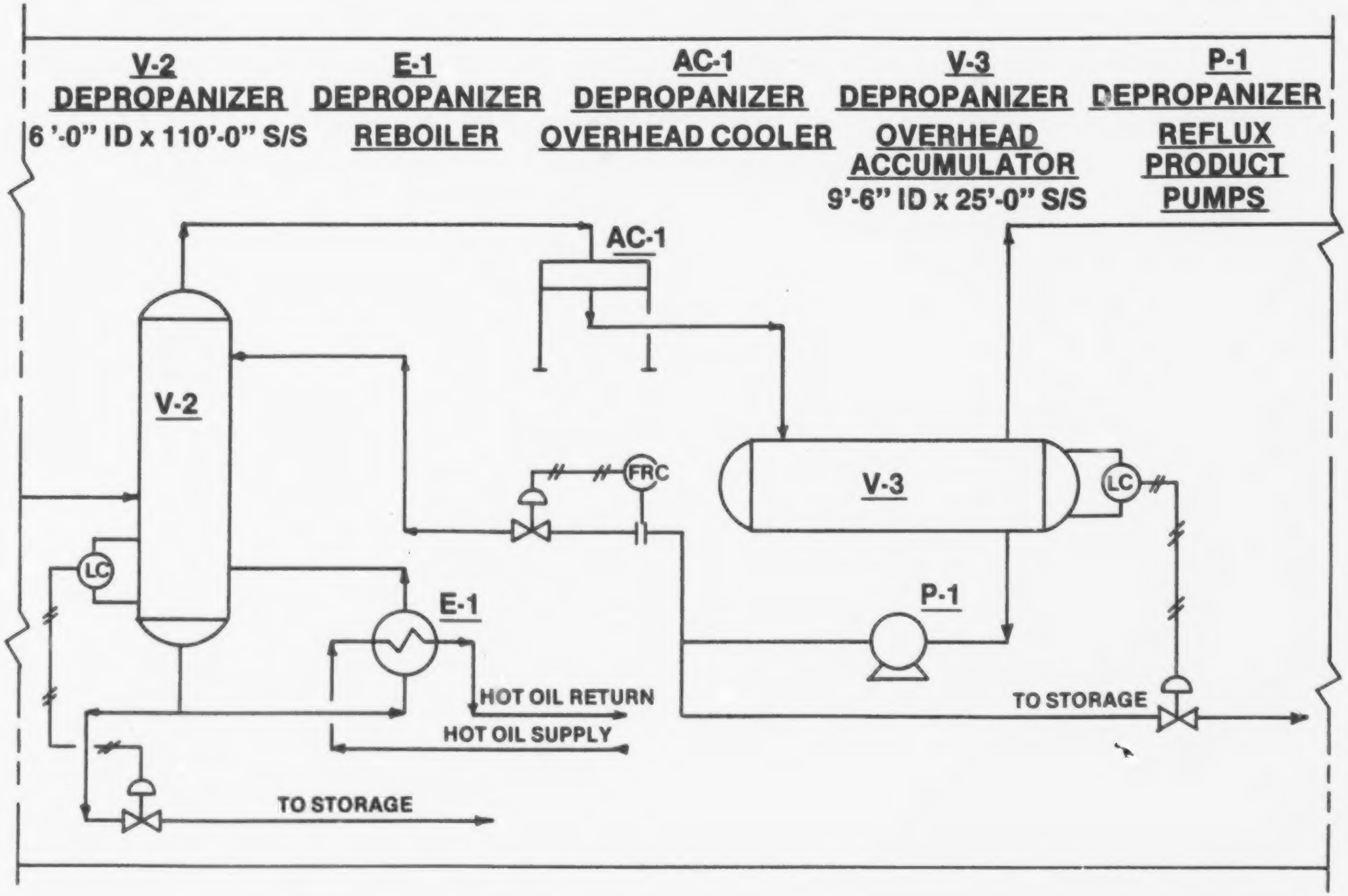

V-1
INLET RECEIVER
10'-0" ID x 80'-0" S/S
INLET FEED
FE
V-1
30-1
LC
LC
TO STORAGE
TO OPEN PIT

Pipe Drafting With CAD, Unit 2
Teacher Page 21

TM 1

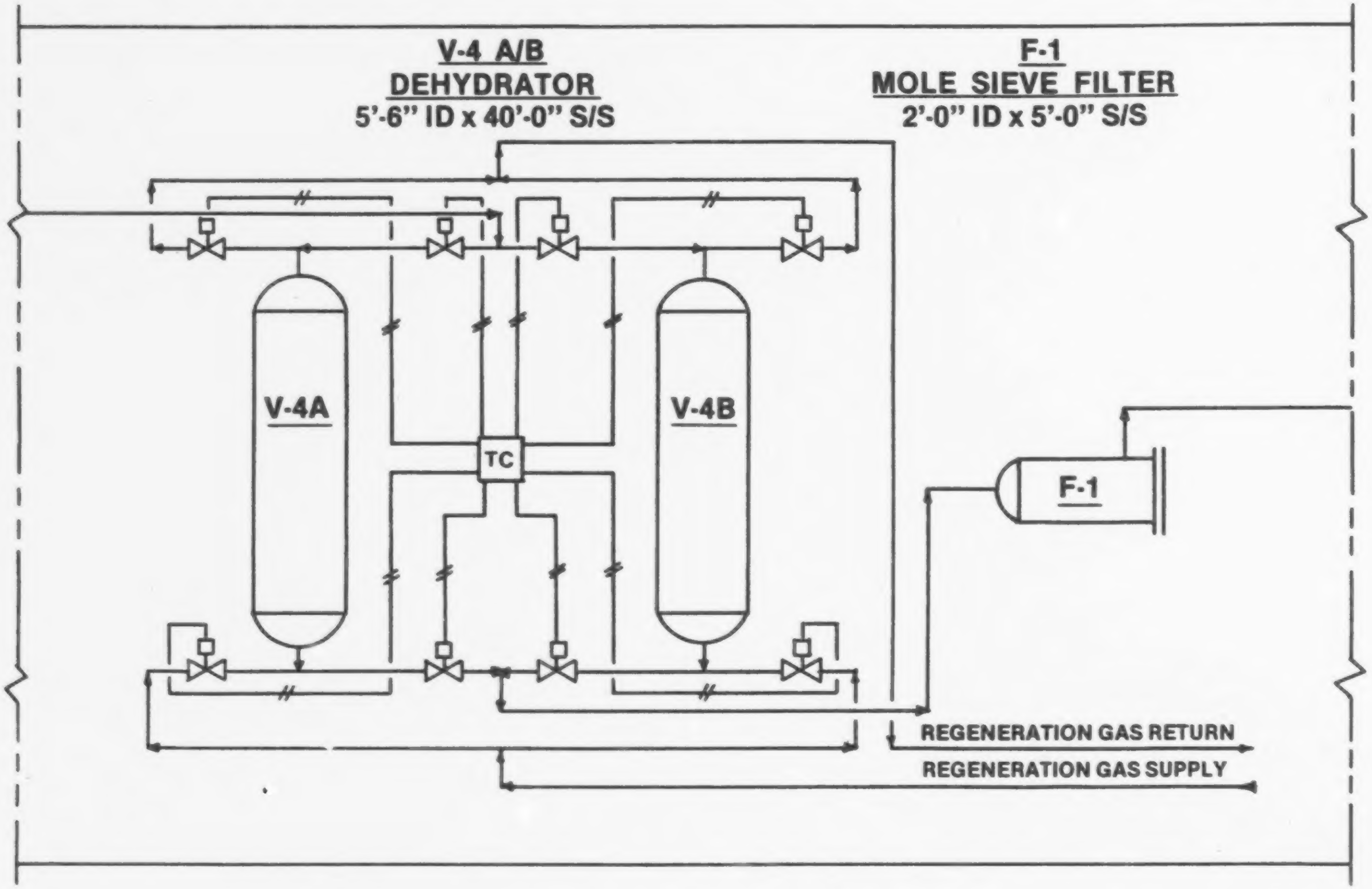
Process Flow Diagram

Sheet 2 of 5


V-2
DEPROPANIZER
6'-0" ID x 110'-0" S/S
E-1
DEPROPANIZER
REBOILER
AC-1
DEPROPANIZER
OVERHEAD COOLER
V-3
DEPROPANIZER
OVERHEAD
ACCUMULATOR
9'-6" ID x 25'-0" S/S
P-1
DEPROPANIZER
REFLUX
PRODUCT
PUMPS
AC-1
V-2
FRC
V-3
LC
LC
E-1
P-1
HOT OIL RETURN
HOT OIL SUPPLY
TO STORAGE
TO STORAGE

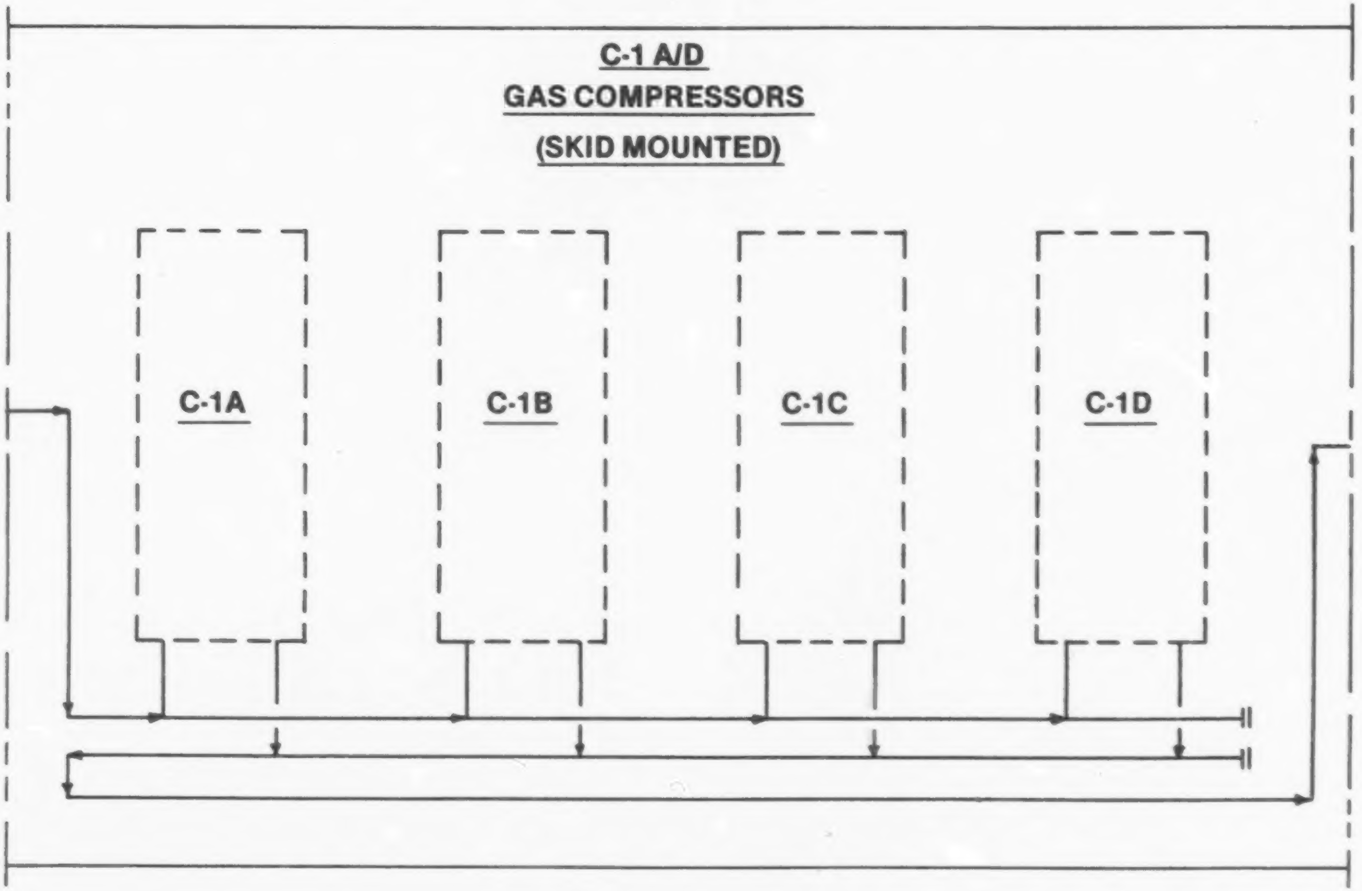
Process Flow Diagram

Sheet 3 of 5


V-4 A/B
DEHYDRATOR
5'-6" ID x 40'-0" S/S
F-1
MOLE SIEVE FILTER
2'-0" ID x 5'-0" S/S
V-4A
TC
V-4B
F-1
REGENERATION GAS RETURN
REGENERATION GAS SUPPLY

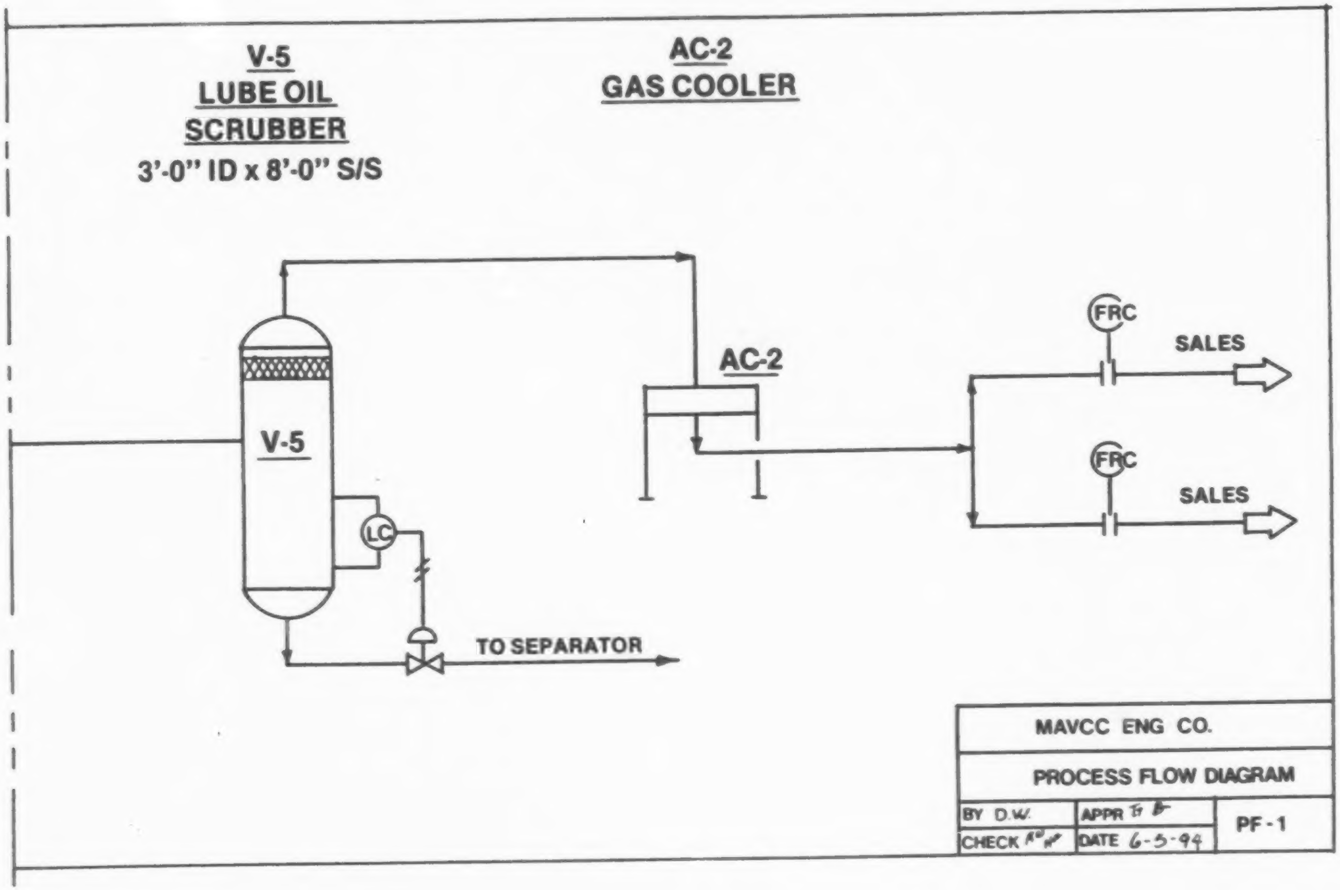
Process Flow Diagram

Sheet 4 of 5


C-1 A/D
GAS COMPRESSORS
(SKID MOUNTED)
C-1A
C-1B
C-1C
C-1D

Process Flow Diagram

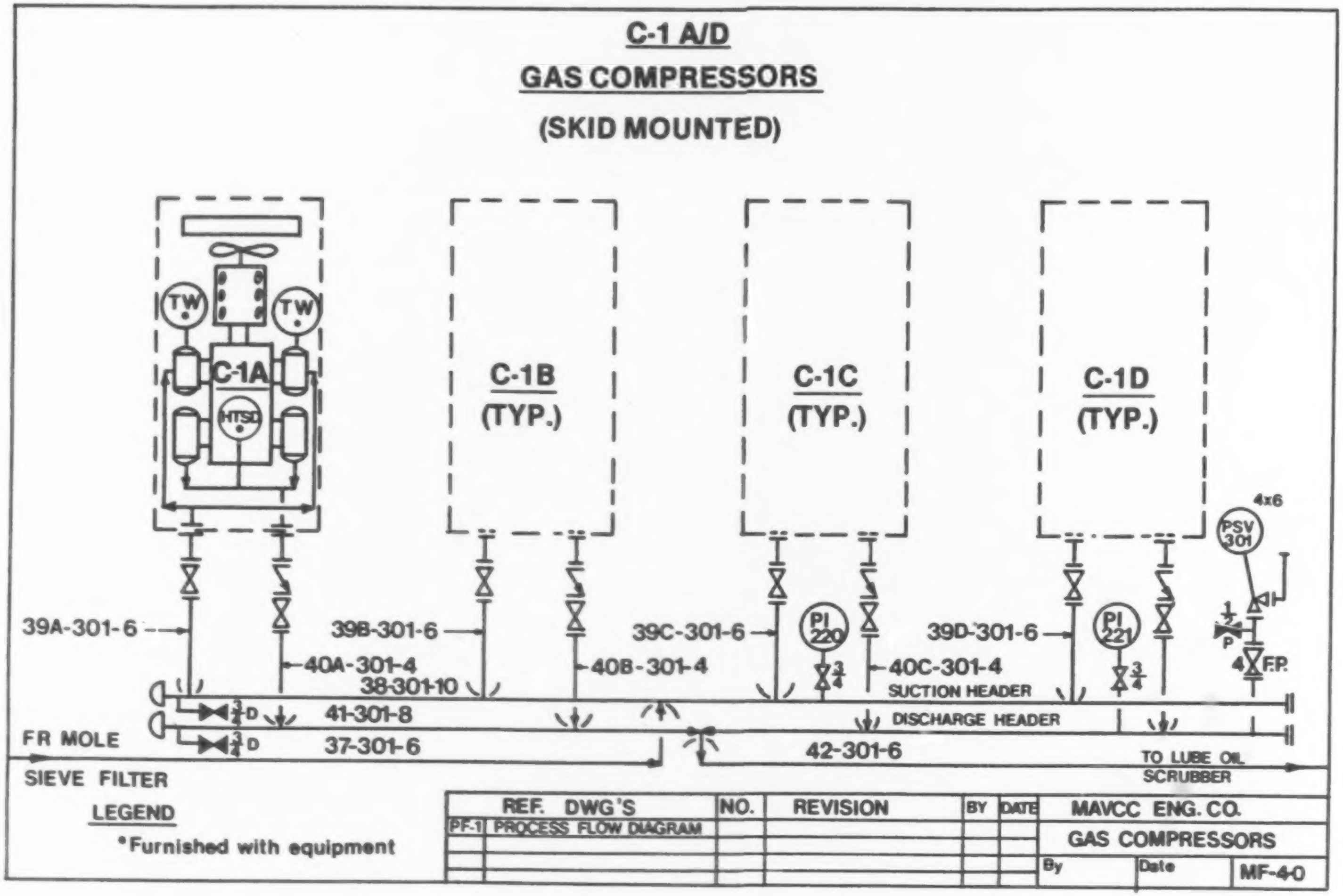
Sheet 5 of 5


V-5
LUBE OIL
SCRUBBER
3'-0" ID x 8'-0" S/S
AC-2
GAS COOLER
V-5
LC
TO SEPARATOR
AC-2
FRC
SALES
FRC
SALES
MAVCC ENG CO.
PROCESS FLOW DIAGRAM
BY D.W.
APPR
CHECK
DATE 6-5-94
PF-1

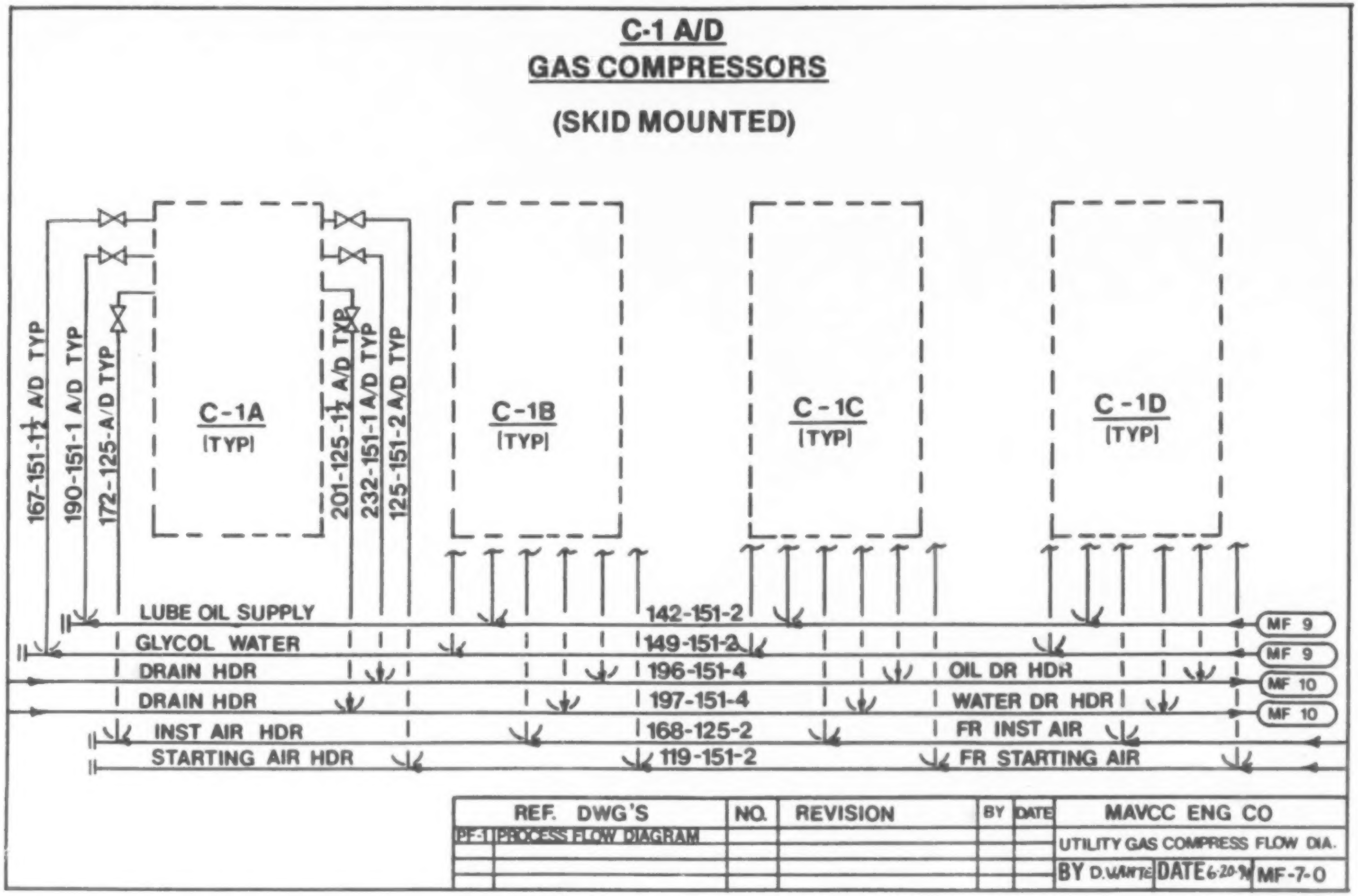
Pipe Drafting With CAD, Unit 2
Teacher Page 29

TM 5

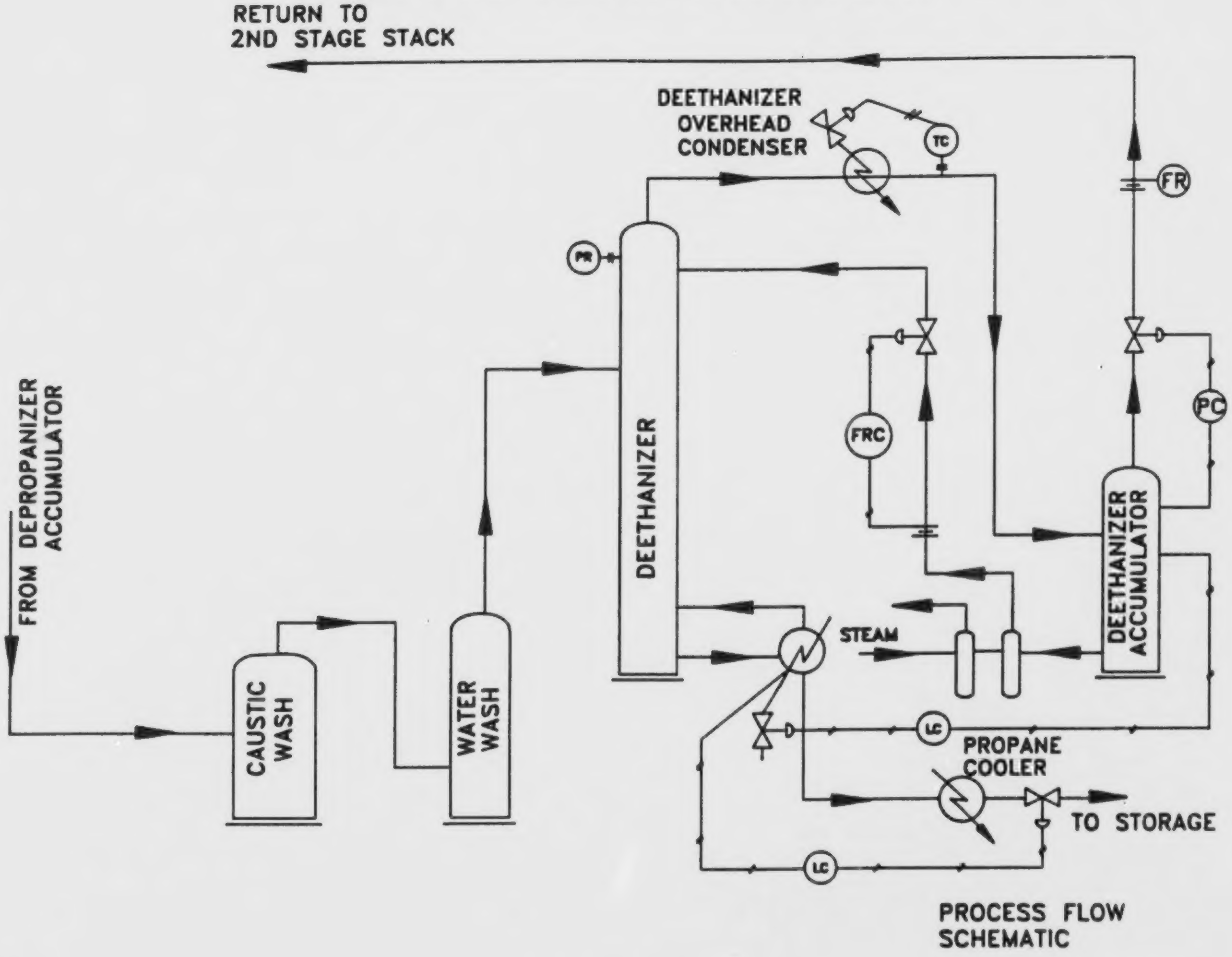
Mechanical Flow Diagram


C-1 A/D
GAS COMPRESSORS
(SKID MOUNTED)
TW
TW
C-1A
HTSD
C-1B
(TYP.)
C-1C
(TYP.)
C-1D
(TYP.)
4x6
PSV
301
39A-301-6
40A-301-4
38-301-10
39B-301-6
40B-301-4
39C-301-6
PI
220
40C-301-4
SUCTION HEADER
39D-301-6
PI
221
3/4
3/4
1/2
P
4
F.P.
3/4 D
3/4 D
41-301-8
DISCHARGE HEADER
FR MOLE
37-301-6
42-301-6
SIEVE FILTER
TO LUBE OIL
SCRUBBER
LEGEND
*Furnished with equipment
REF. DWG'S
NO.
REVISION
BY
DATE
PF-1
PROCESS FLOW DIAGRAM
MAVCC ENG. CO.
GAS COMPRESSORS
By
Date
MF-4-0

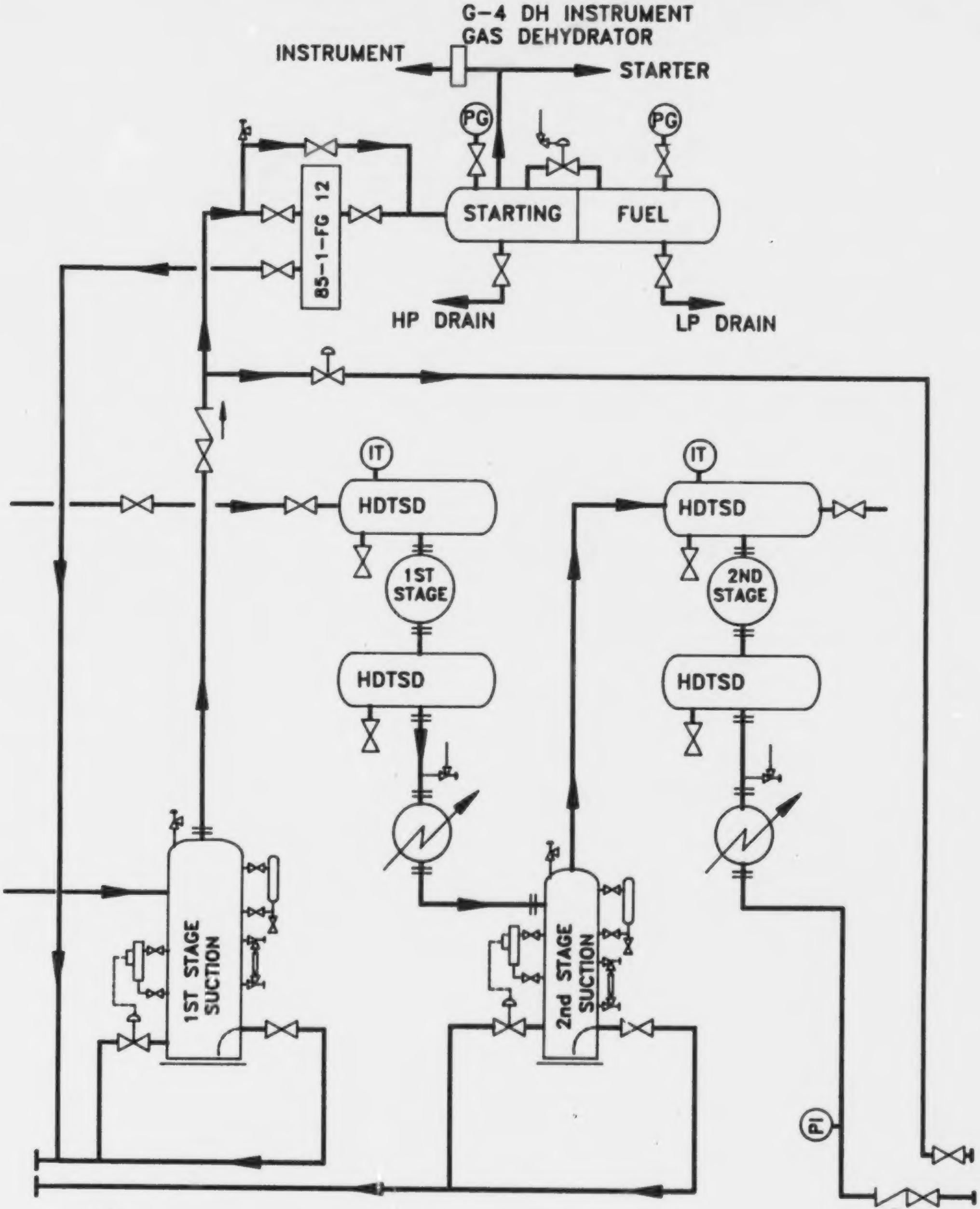
Utility Flow Diagram


C-1 A/D
GAS COMPRESSORS
(SKID MOUNTED)
C-1A
(TYP)
C-1B
(TYP)
C-1C
(TYP)
C-1D
(TYP)
167-151-1½ A/D TYP
190-151-1 A/D TYP
172-125-A/D TYP
201-125-1½ A/D TYP
232-151-1 A/D TYP
125-151-2 A/D TYP
LUBE OIL SUPPLY
142-151-2
GLYCOL WATER
149-151-2
DRAIN HDR
196-151-4
OIL DR HDR
DRAIN HDR
197-151-4
WATER DR HDR
INST AIR HDR
168-125-2
FR INST AIR
STARTING AIR HDR
119-151-2
FR STARTING AIR
MF 9
MF 9
MF 10
MF 10
REF. DWG'S
NO.
REVISION
BY
DATE
MAVCC ENG CO
PF-1 PROCESS FLOW DIAGRAM
UTILITY GAS COMPRESS FLOW DIA.
BY D.WAITE
DATE 6-20-9
MF-7-0

Process Flow Diagram


RETURN TO
2ND STAGE STACK
DEETHANIZER
OVERHEAD
CONDENSER
TC
FR
PR
DEETHANIZER
FRC
PC
FROM DEPROPANIZER
ACCUMULATOR
DEETHANIZER
ACCUMULATOR
STEAM
CAUSTIC
WASH
WATER
WASH
LC
PROPANE
COOLER
TO STORAGE
LC
PROCESS FLOW
SCHEMATIC

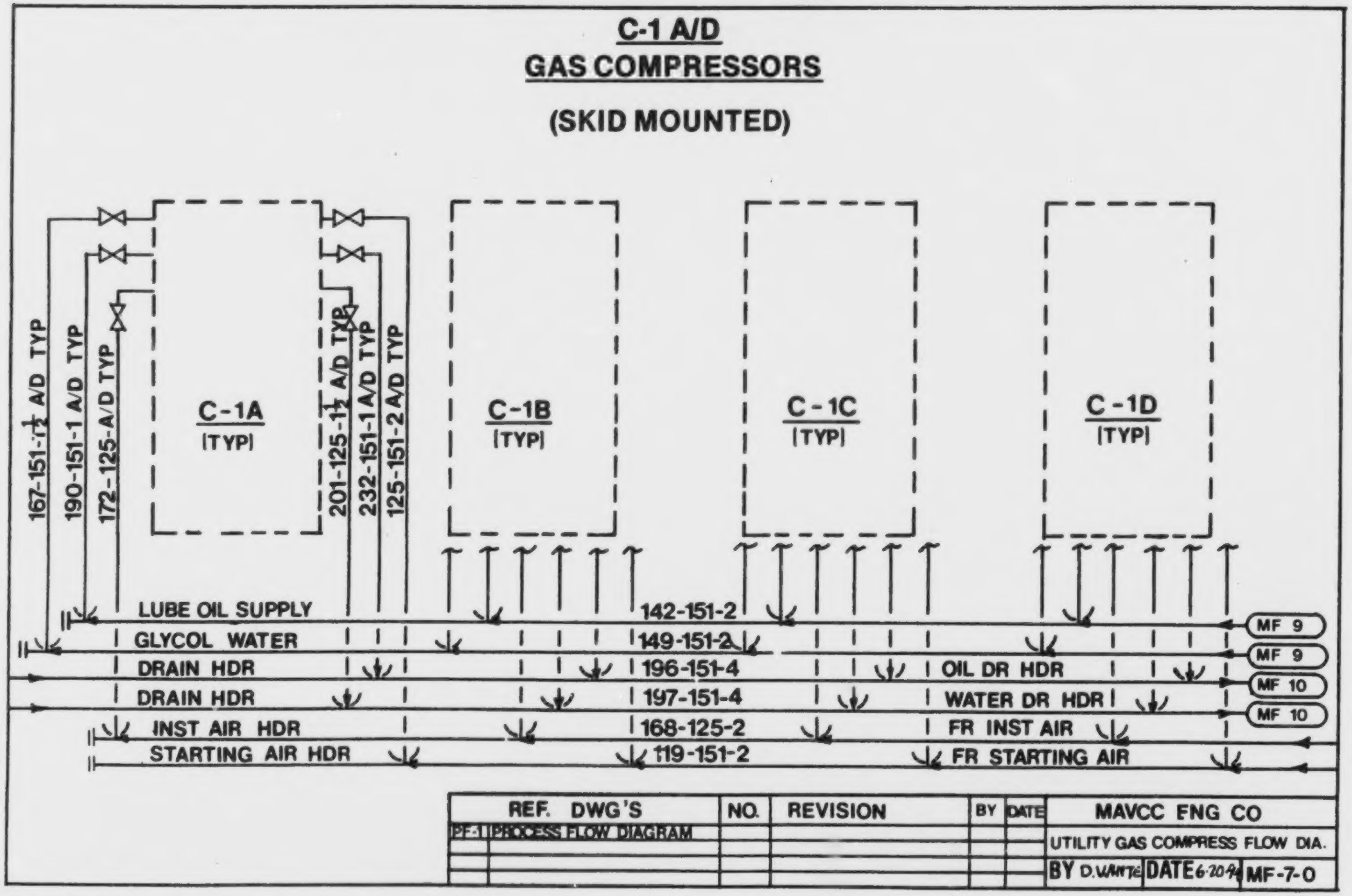
Mechanical Flow Diagram


G-4 DH INSTRUMENT
GAS DEHYDRATOR
INSTRUMENT
STARTER
PG
PG
85-1-FG 12
STARTING
FUEL
HP DRAIN
LP DRAIN
IT
IT
HDTSD
HDTSD
1ST STAGE
2ND STAGE
HDTSD
HDTSD
1ST STAGE SUCTION
2nd STAGE SUCTION
PI

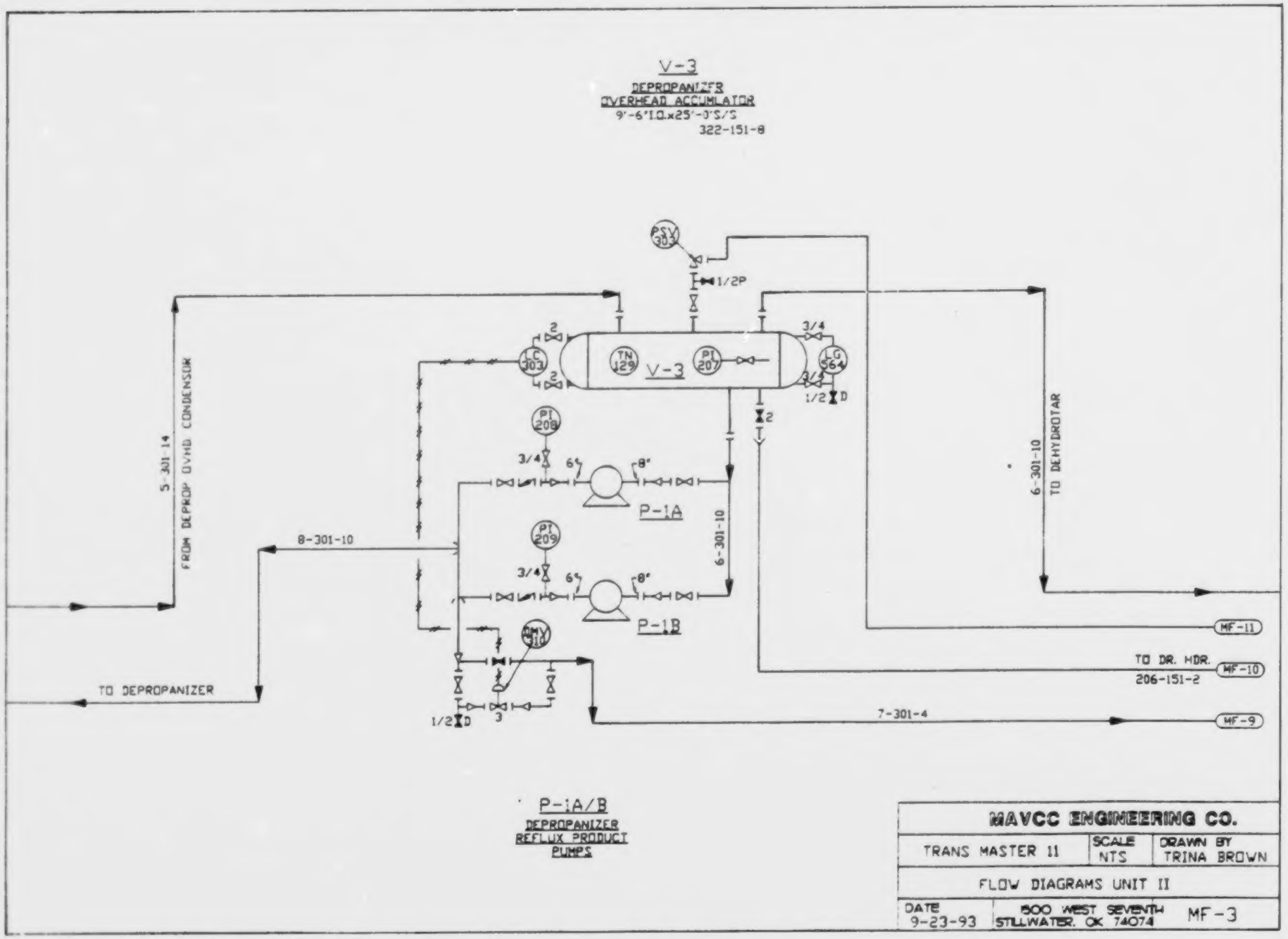
NOTE:
ALL VENT LINES SHALL BE DIRECTED
ASAY FROM THE ENGINE EXHAUST AND
SHALL DISCHARGE NOT LESS THAN
SEVEN (7) FEET ABOVE TOP OF SLAB

FLOW DIAGRAM FOR HIGH SPEED
SKID MOUNTED BOOSTER COMPS

Utility Flow Diagram


C-1 A/D
GAS COMPRESSORS
(SKID MOUNTED)
C-1A
(TYP)
C-1B
(TYP)
C-1C
(TYP)
C-1D
(TYP)
167-151-1½ A/D TYP
190-151-1 A/D TYP
172-125-A/D TYP
201-125-1½ A/D TYP
232-151-1 A/D TYP
125-151-2 A/D TYP
LUBE OIL SUPPLY
142-151-2
GLYCOL WATER
149-151-2
DRAIN HDR
196-151-4
OIL DR HDR
DRAIN HDR
197-151-4
WATER DR HDR
INST AIR HDR
168-125-2
FR INST AIR
STARTING AIR HDR
119-151-2
FR STARTING AIR
MF 9
MF 9
MF 10
MF 10
REF. DWG'S
NO.
REVISION
BY
DATE
PF-1 PROCESS FLOW DIAGRAM
MAVCC ENG CO
UTILITY GAS COMPRESS FLOW DIA.
BY D.WAITE
DATE 6-20-94
MF-7-0

Laying out a Flow Diagram


V-3
DEPROPANIZER
OVERHEAD ACCUMLATOR
9'-6"I.D.x25'-0"S/S
322-151-8
PSV 303
1/2P
2
LC 303
2
TN 129
V-3
PI 207
3/4
LG 564
3/4
1/2 D
2
PI 208
3/4
6"
8"
P-1A
PI 209
3/4
6"
8"
P-1B
5-301-14
FROM DEPROP OVHD CONDENSOR
8-301-10
6-301-10
6-301-10
TO DEHYDROTAR
FMV 310
1/2 D
3
TO DEPROPANIZER
7-301-4
MF-11
TO DR. HDR.
206-151-2
MF-10
MF-9
P-1A/B
DEPROPANIZER
REFLUX PRODUCT
PUMPS
MAVCC ENGINEERING CO.
TRANS MASTER 11
SCALE
NTS
DRAWN BY
TRINA BROWN
FLOW DIAGRAMS UNIT II
DATE
9-23-93
500 WEST SEVENTH
STILLWATER, OK 74074
MF-3

Pipe Drafting With CAD, Unit 2
Teacher Page 41

TM 11

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Flow Diagrams
Unit 2

Information Sheet

1. **Terms and definitions**

   a. **Downstream** — In the direction of the product flow

   b. **Equipment** — Large vessels and implements used in the operation of a plant

   c. **Flange** — A method of joining pipe components and equipment for later dismantling and maintenance

   d. **Flow diagram** — A schematic diagram not drawn to scale that shows direction of flow on lines and equipment, indicates size, temperature, pressure, and flow rates

   e. **Instrument air** — Oil-free, moisture-free, compressed air system used to operate pneumatic control devices

   f. **Instrumentation** — Devices used to control and/or indicate temperature, pressure, level, or flow in a pipe or equipment

   g. **Insulation** — Material used on the outside of pipe or equipment to keep temperature constant and to protect personnel

   h. **Pneumatic** — Moved or worked on by air pressure

   i. **Schematic diagram** — A line drawing which illustrates the arrangement and relationship of components

   j. **Skid** — A large flat structure that has equipment and controls mounted on it for ease of moving

   k. **Upstream** — In the direction opposite the product flow

   l. **Utility air** — Air used in cleanup operations, in drive motors, and other service functions

2. **Purposes of a piping control system**

   a. A piping control system permits the smooth and safe operation of a plant.

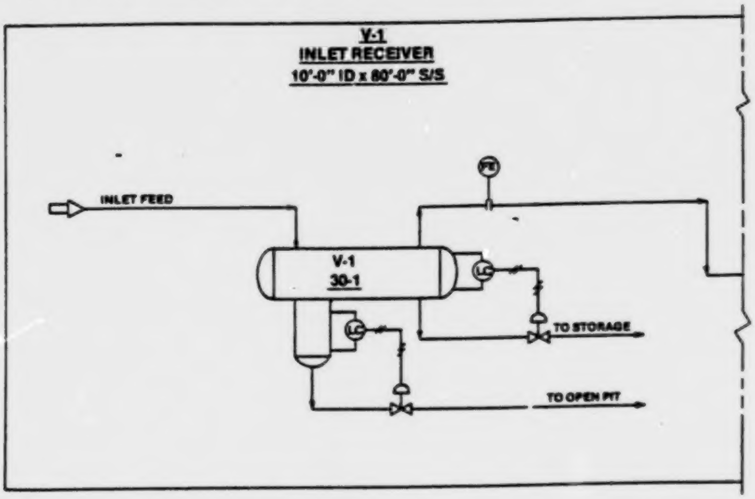
   b. A piping control system signals operators when there are malfunctions in plant operations.

   c. A piping control system records valuable operating paramaters that require monitoring.

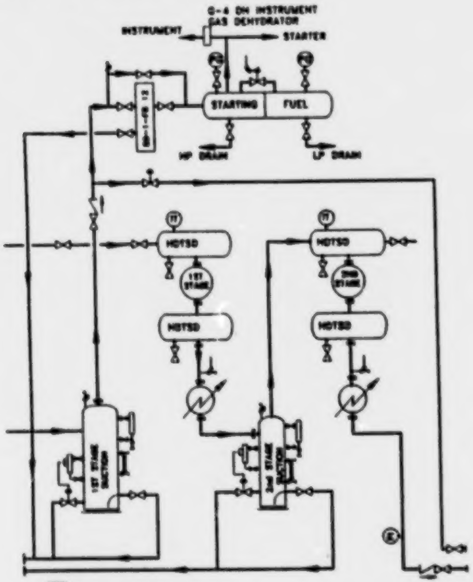
Information Sheet

3. Types of flow diagrams and their applications

a. **Process flow diagram** — Used by process engineers in designing what major equipment and lines are needed for certain operations in a plant


V-1
INLET RECEIVER
10'-0" ID x 80'-0" S/S
INLET FEED
V-1
30-1
LC
LC
TO STORAGE
TO OPEN PIT

b. **Mechanical flow diagram** — Derived from process flow diagrams and used in sizing pipe, system specifications, insulations, line numbers, and instrumentation controls necessary to process a product

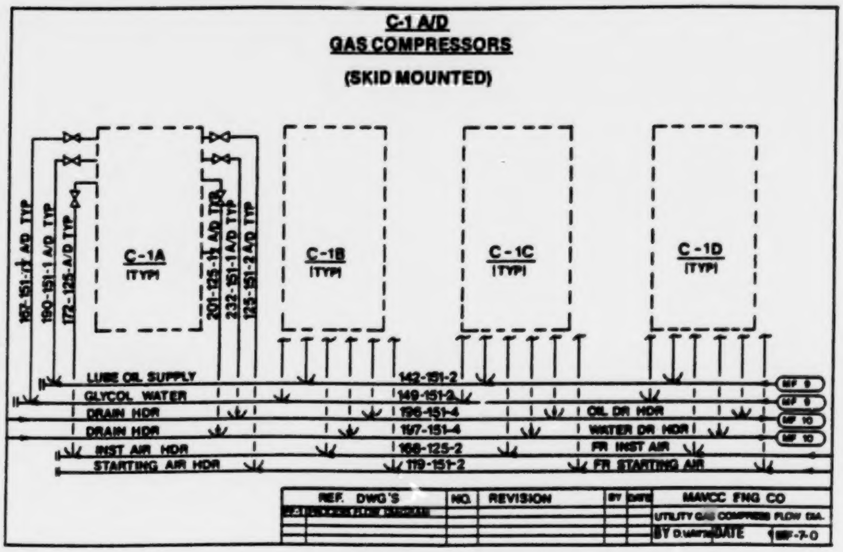

G-4 DH INSTRUMENT GAS DEHYDRATOR
INSTRUMENT
STARTER
STARTING
FUEL
HP DRAIN
LP DRAIN
HDTSD
1ST STAGE
HDTSD
HDTSD
2ND STAGE
HDTSD
1ST STAGE SUCTION
2ND STAGE SUCTION

NOTE:
ALL VENT LINES SHALL BE DIRECTED AWAY FROM THE ENGINE EXHAUST AND SHALL DISCHARGE NOT LESS THAN SEVEN (7) FEET ABOVE TOP OF SLAB

FLOW DIAGRAM FOR HIGH SPEED SKID MOUNTED BOOSTER COMPS

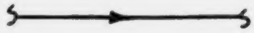
Information Sheet

c. **Utility flow diagram** — Derived from mechanical flow diagrams and used to show all other necessary piping, system specifications, and minor equipment needed to process a product

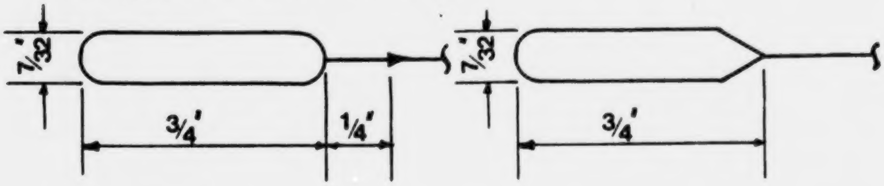

C-1 A/D
GAS COMPRESSORS
(SKID MOUNTED)
C-1A (TYP)
C-1B (TYP)
C-1C (TYP)
C-1D (TYP)
190-151-1 A/D TYP
172-125-A/D TYP
201-125-1 A/D TYP
232-151-1A/D TYP
125-151-2 A/D TYP
LUBE OIL SUPPLY
GLYCOL WATER
DRAIN HDR
DRAIN HDR
INST AIR HDR
STARTING AIR HDR
142-151-2
149-151-2
196-151-4
197-151-4
168-125-2
119-151-2
OIL DR HDR
WATER DR HDR
FR INST AIR
FR STARTING AIR
MF 9
MF 9
MF 10
MF 10
REF. DWG'S
NO.
REVISION
BY
DATE
MAVCC ENG CO
UTILITY GAS COMPRESS FLOW DIA.
BY
DATE
MF-7-0

4. Common flow diagram piping symbols

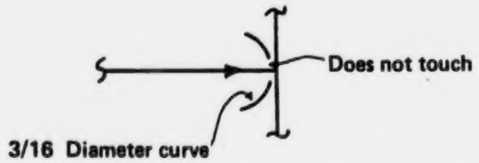
a. Flow direction arrow



b. Flow diagram transfer symbol (balloon)

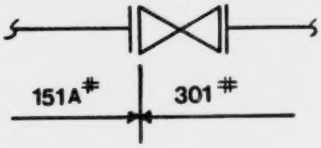

7/32"
3/4"
1/4"
7/32"
3/4"

c. Line number break


Does not touch
3/16 Diameter curve

Information Sheet

d. Line rating change

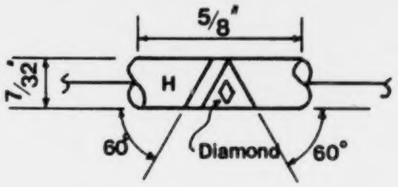


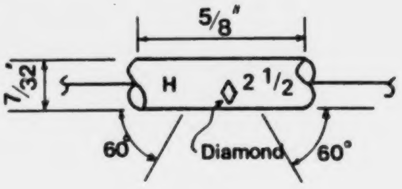
e. Insulation on pipe

(1) Diagonal lines are used to indicate number of full inches (left side) and number of half inches (right side) of insulation. Some companies indicate the number of inches of insulation in numeric form.

(2) Type of insulation is indicated with abbreviations: **H** - Hot, **C** - Cold, **HT** - Heat Trace, **ST** - Steam Trace, and **HP** - Hot Personal.

(3) Flange marks are drawn as a small diamond.

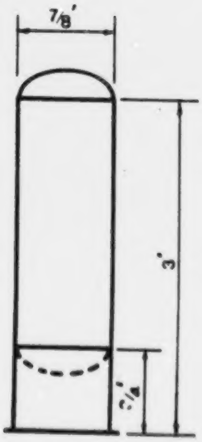

5/8"
7/32"
H
60°
Diamond
60°


5/8"
7/32"
H
2 1/2
60°
Diamond
60°

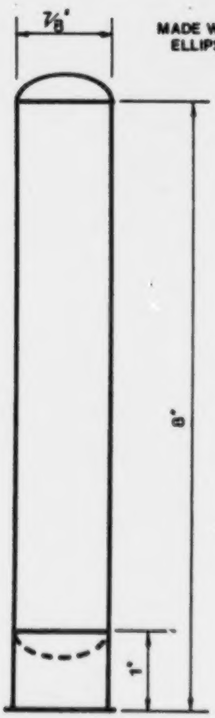
Information Sheet

5. Common flow diagram equipment symbols

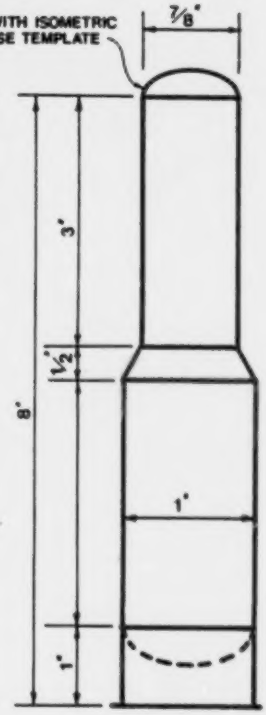
a. Vertical vessel, tower, or scrubber



VERTICAL SCRUBBER

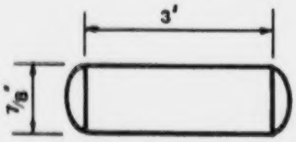


VERTICAL VESSEL

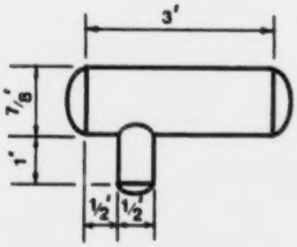

MADE WITH ISOMETRIC ELLIPSE TEMPLATE
7/8'
3'
1/2'
8'
1'
1'

VERTICAL FRACTIONATOR

b. Horizontal vessel



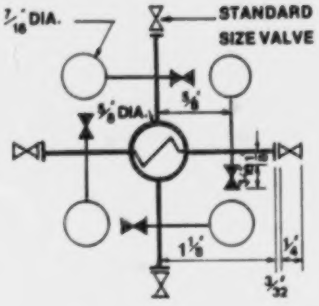
HORIZONTAL VESSEL



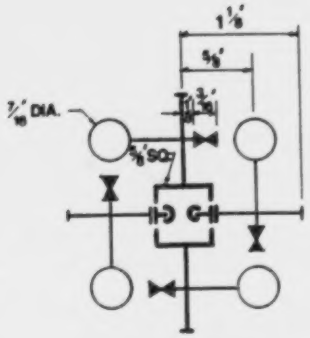
HORIZONTAL SEPARATOR

Information Sheet

c. Heat exchanger

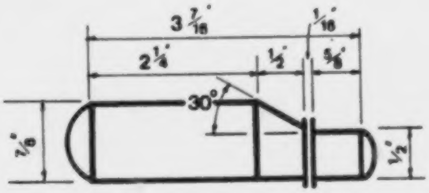

7/16" DIA.
STANDARD SIZE VALVE
5/8" DIA.
5/8"
1 1/8"
1/4"
3/32"

SHELL AND TUBE
EXCHANGER

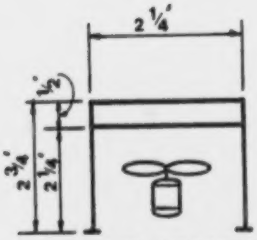

1 1/8"
5/8"
7/16" DIA.
3/16"
5/8" SQ.

FIN TUBE
EXCHANGER

d. Reboiler or chiller


3 7/16"
1/16"
2 1/4"
1/2"
5/8"
30°
7/8"
1/2"

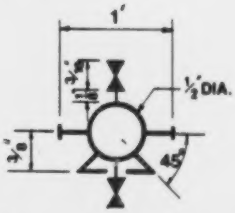
e. Air fin exchanger


2 1/4"
1/2"
2 3/4"
2 1/4"

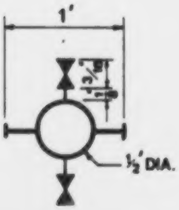
AIR COOLER
(FIN FAN)

Information Sheet

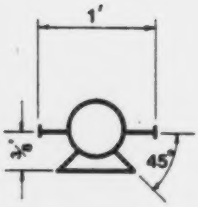
f. Pumps


1'
3/8"
1/8"
1/2" DIA.
3/8"
45°

CENTRIFUGAL PUMP

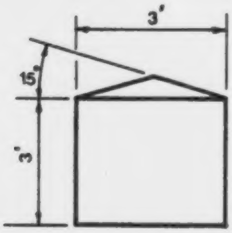

1'
3/8"
1/8"
1/2" DIA.

INLINE PUMP



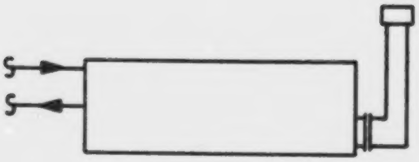
CAN TYPE PUMP

g. Storage tank

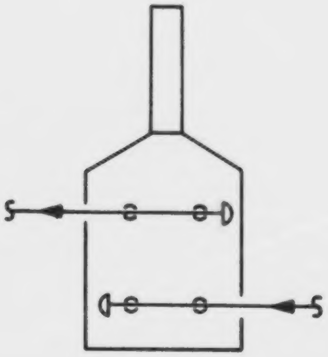


STORAGE TANK

h. Fired heater



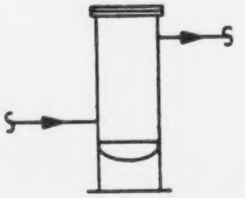
INDIRECT FIRED HEATER



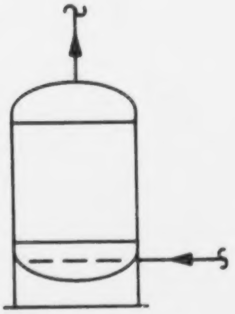
DIRECT FIRED HEATER

Information Sheet

i. Filter

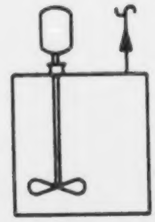


FILTER



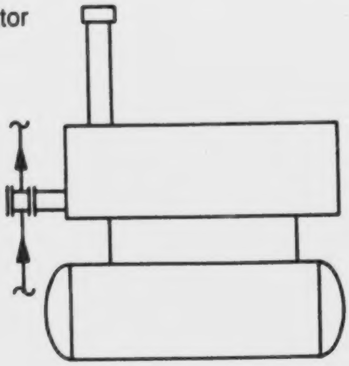
SEA WATER FILTER

j. Mix tank



MIX TANK

k. Glycol reconcentrator



Information Sheet

6. Characteristics of a sheet numbering system

a. The first letter in a sheet numbering system indicates the type of flow diagram.

   (1) **P** or **PF** is Process Flow.

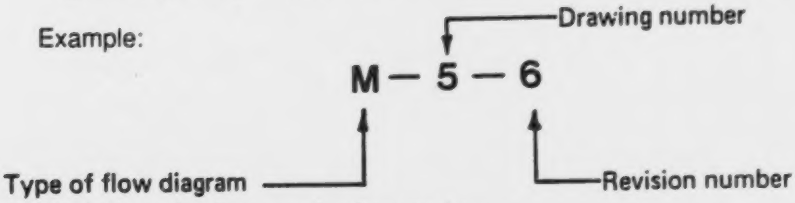
   (2) **M** or **MF** is Mechanical Flow.

   (3) **U** or **UF** is Utility Flow.

b. The first number in a sheet numbering system indicates the page number, as in the pages of a book.

c. The second number in a sheet numbering system indicates how many engineering changes have been made since the drawing was first approved.

Example:


Drawing number
M — 5 — 6
Type of flow diagram
Revision number

7. Characteristics of a line numbering system

a. The first group of numbers in a line numbering system indicates the in-plant line number.

b. The second group of numbers in a line numbering system indicates the pressure rating of a line.

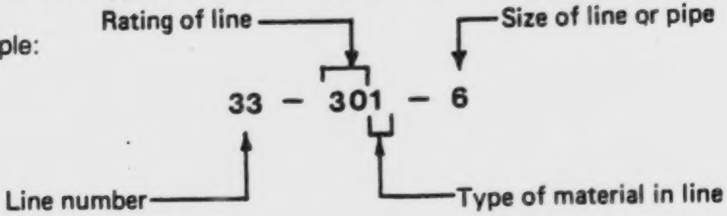
   Note: Pressure notation usually requires adding an extra zero. In other words, a pressure notation of 30 would mean 300.

c. The third group of numbers in a line numbering system indicates the type of material in the line, and most companies have their own standards.

d. The fourth group of numbers in a line numbering system indicates the size of the line or pipe.

e. Line numbers appear on a flow sheet at least one time above the pipe.

Example:


Rating of line
Size of line or pipe
33 — 301 — 6
Line number
Type of material in line

Information Sheet

8. Guidelines for using an equipment numbering system

a. Use the first letter in an equipment numbering system to indicate the type of equipment by using the first letter or letters of the equipment name.

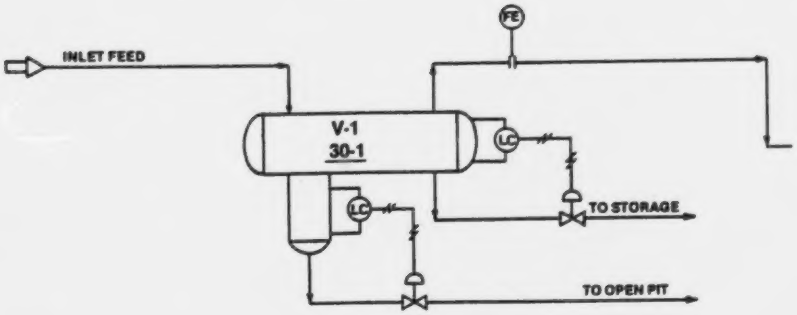
Example: C is compressor, D is dryer, E is exchanger, F is filter, G is generator, H is heater, M is miscellaneous, P is pump, S is sump, T is tank, V is vessel, and WH is wellhead.

b. Use the first number in an equipment numbering system as the number of the equipment and keep that assigned number consistent on process, mechanical, and utility flow diagrams as well as necessary detail drawings.

c. Place the equipment number and equipment label in the 3 1/2" margin above or below the vessel as it appears on the flow sheet.

Example:

V-1
INLET RECEIVER
10'-0" ID x 80'-0" S/S



d. Place the equipment number either on the equipment symbol or as close as possible to smaller symbols.

Information Sheet

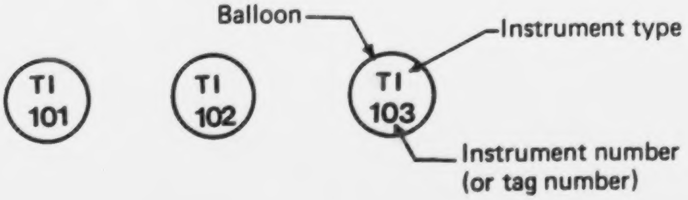
9. Characteristics of an instrumentation numbering system

a. The first letter in an instrumentation number system indicates the type of instrument.

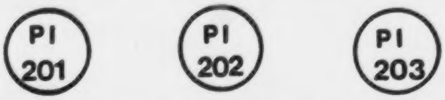
Example: F is flow, L is level, LL is liquid level, P is pressure, H is hand operated, T is temperature, S is speed, V is vibration, and Q is quick.

b. Additional instrumentation letters are used as needed.

Example: E is element, I is indicating or indicator, C is control or controller, V is valve, R is recorder, G is gauge, A is alarm, D is differential, W is well, and S is switch.

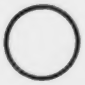


c. The number in the bottom half of an instrument balloon indicates the instrument number, and that assigned number stays consistent on process, mechanical, and utility flow diagrams as well as any necessary detail drawings.

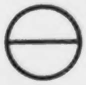


d. An instrumentation balloon also includes mounting information.

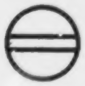
(1) Locally mounted



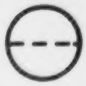
(2) Control room or board mounted



(3) Field board mounted



(4) Mounted behind board



Information Sheet

10. Guidelines for using a flow line transfer numbering system

a. Use the flow line transfer numbering system to permit the flow line to be followed from one flow sheet to another by creating balloons.

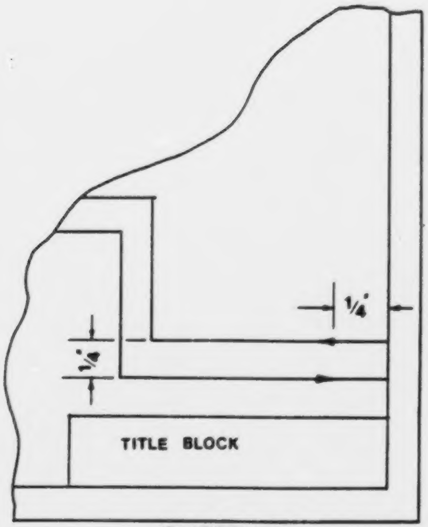
b. Place balloons only on lines that end on one sheet and skip one or more sheets before starting again.

c. Place flow arrows, not balloons, on lines that end on one sheet and start immediately on the next sheet.

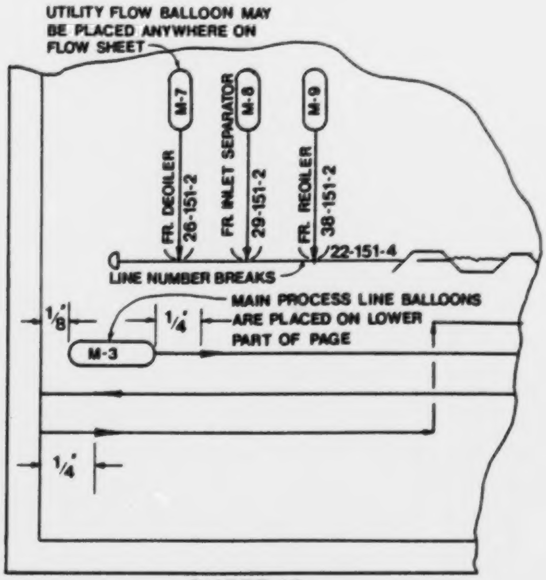
d. Never place revision numbers on a transfer balloon.

e. Place product flow transfer symbols in the upper or lower 3 1/2″ space.

f. Place utility transfer symbols anywhere on the drawing they will fit with clarity.


1/4″
1/4″
TITLE BLOCK

SHEET 15


UTILITY FLOW BALLOON MAY BE PLACED ANYWHERE ON FLOW SHEET
M-7
M-8
M-9
FR. DEOILER 26-151-2
FR. INLET SEPARATOR 29-151-2
FR. REOILER 38-151-2
22-151-4
LINE NUMBER BREAKS
1/8″
1/4″
MAIN PROCESS LINE BALLOONS ARE PLACED ON LOWER PART OF PAGE
M-3
1/4″

SHEET 16

Information Sheet

11. **Types of control systems and their functions**

    a. **Level controller** — Controls liquid level in equipment

    b. **Temperature controller** — Controls temperature in a line or equipment

    c. **Flow controller** — Controls flow rate and amount of liquid or gas in a line

    d. **Pressure controller** — Controls how much pressure is to leave or enter a line, vessel, or tank

12. **Steps in typical level control operation**

    a. The cycle starts as liquid rises to a high liquid level.

    b. A float in the level controller pushes the actuating rod up.

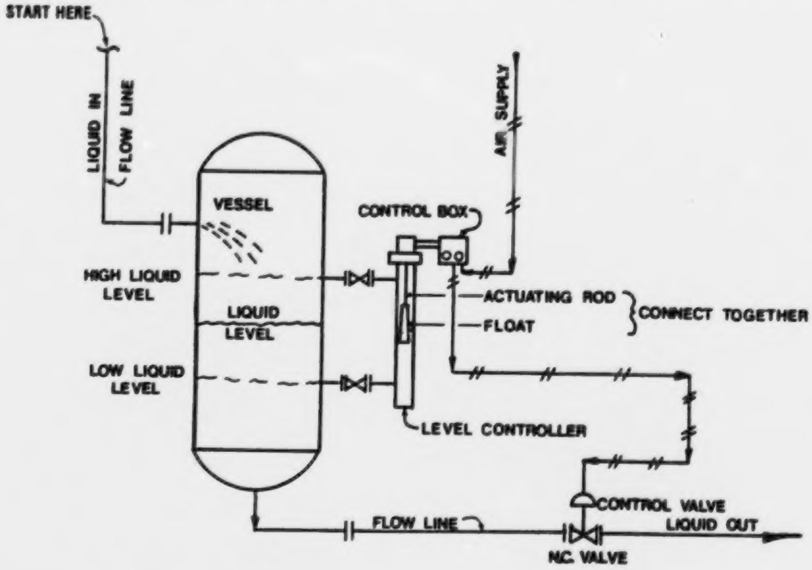
    c. A small valve in the control box opens to allow air to pass through the control box to the control valve.

    d. The air supply opens the control valve.

    e. The liquid in the vessel falls to a low liquid level.

    f. The float in the level controller falls to a low position and closes a small valve in the control box.

    g. The air supply is shut off, the control valve closes, and the cycle starts over.


START HERE
LIQUID IN
FLOW LINE
AIR SUPPLY
VESSEL
CONTROL BOX
HIGH LIQUID LEVEL
LIQUID LEVEL
ACTUATING ROD
FLOAT
CONNECT TOGETHER
LOW LIQUID LEVEL
LEVEL CONTROLLER
CONTROL VALVE
FLOW LINE
LIQUID OUT
N.C. VALVE

Information Sheet

13. Guidelines for laying out a flow diagram

a. Draw process flow diagrams on roll size paper (usually 24, 30, or 36″ wide).

b. Draw mechanical and utility flow diagrams on D size paper, 22 × 34 or 24 × 36.

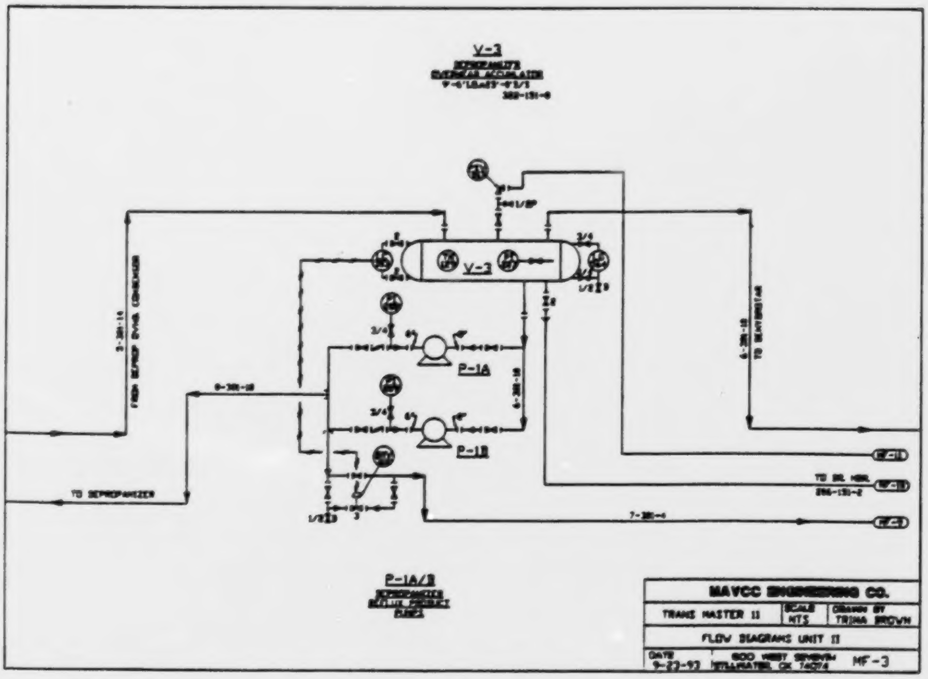
c. Do not draw flow diagrams to scale.

d. Allow 3½ inches from bottom and top border for equipment labels, flow lines, and transfer lines.

e. Show flow lines from equipment with dark, thick lines.

f. Give horizontal lines precedence over vertical lines.

g. Space flow lines at least ¼″ apart.


V-3
V-3
3/4
1/2
P-1A
P-1B
3/4
TO DEPROPANIZER
7-3
P-1A/B
MF-3
MAVCC ENGINEERING CO.
TRANS MASTER II
SCALE
NTS
DRAWN BY
TRINA BROWN
FLOW DIAGRAMS UNIT II
DATE
9-23-93
STILLWATER, OK 74074
MF-3

Flow Diagrams
Unit 2

Assignment Sheet 1—Identify Parts of Line Numbers

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Correctly identify line number	______
Correctly identify pressure rating	______
Correctly identify material in line	______
Correctly identify pipe size	______

Directions: For each give pipe number correctly identify each of its components.

	301-301-30	26-601-24	192-301-6	406-605-12
Line number				
Pressure rating				
Material in line				
Size of line				

Flow Diagrams
Unit 2

Assignment Sheet 2—Draw Flow Diagram Equipment Symbols

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Equipment symbols drawn to correct proportions	______
Correct ANSI symbols used	______
Equipment symbols correctly named	______
Equipment symbols correctly stored	______

Instructions: Draw the equipment symbols to the appropriate proportions. Name each drawing as indicated and save to ______\SYM directory. Place each drawing with the lower left corner beginning at location 0,0, and omit any pipe line hook-ups.

Procedure

1. Vertical scrubber Name: VSCR
2. Vertical vessel Name: VVES
3. Vertical fractionator Name: VFRAC
4. Horizontal vessel Name: HV
5. Horizontal vessel with separator Name: HVSEPA
6. Reboiler Name: REBOIL
7. Shell and tube heat exchanger Name: HESHTU
8. Fin tube heat exchanger Name: HEFINTU
9. Air fin heat exchanger Name: HEAIRFIN

Assignment Sheet 2

10. Centrifugal pump Name: PUMPCENT
11. Inline pump Name: PUMPINLI
12. Can type pump Name: PUMPCAN
13. Indirect fired heater Name: HEATIND
14. Direct fired heater Name: HEATDIR
15. Filter Name: FILT
16. Sea water filter Name: FILTSEA
17. Mix tank Name: MIXTANK
18. Storage tank Name: ST
19. Glycol reconcentrator Name: RECON

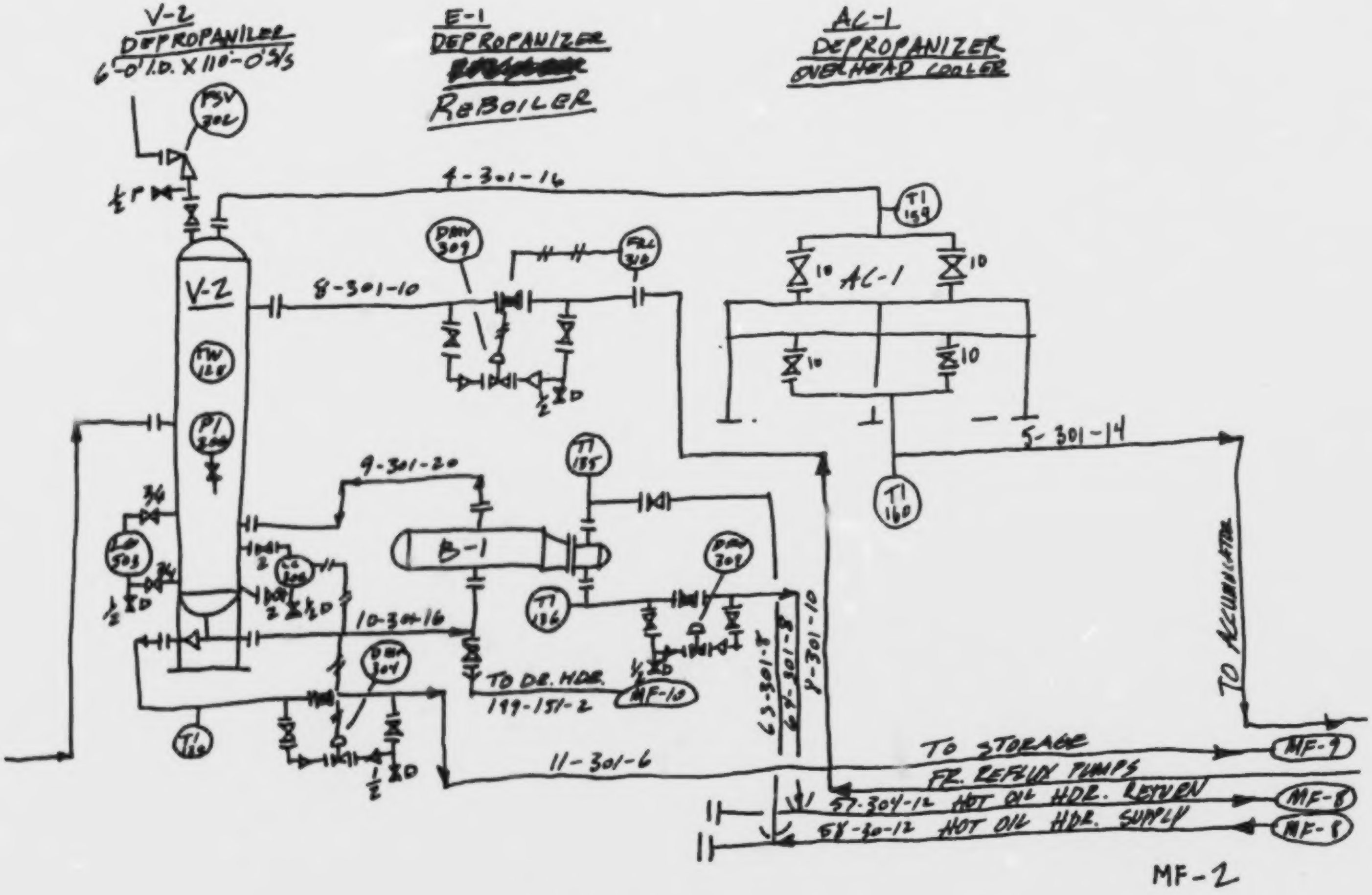
Flow Diagrams
Unit 2

Assignment Sheet 4—Draw a Mechanical Flow Diagram With Depropanizers

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Equipment symbols drawn to correct proportions	_____
Correct ANSI symbols used	_____
Equipment symbols correctly tagged	_____
Lines correctly labeled	_____
Title block filled out correctly	_____
Drawing correctly plotted	_____
Drawing correctly stored	_____

Instructions: Given an engineers sketch, use CAD software to draw, plot, and store the drawing. Make special effort to ensure that each vessel and line is correctly noted and tagged. Be sure to note on each updated drawing that the CAD drawing is a revision of a current drawing. Use a separate layer for equipment, tags, lines, border and title block. Store the drawing named A-8875 to a diskette under a FLOW subdirectory.


V-2
DEPROPANIZER
6'-0" I.D. X 110'-0" S/S
E-1
DEPROPANIZER
REBOILER
AC-1
DEPROPANIZER
OVERHEAD COOLER
PSV 302
1/2" P
4-301-16
TI 159
DPV 309
FRC 310
8-301-10
V-2
TW 128
PI 300
AC-1
10
10
10
10
5-301-14
TI 160
TI 135
9-301-20
B-1
3/4
3/4
LG 303
1/2 D
2
LC 300
2
1/2 D
DPV 308
TI 136
10-301-16
DPV 304
TO DR. HDR.
199-151-2
MF-10
1/2 D
TI 130
1/2 D
11-301-6
63-301-8
64-301-8
4-301-10
TO ACCUMULATOR
TO STORAGE
MF-9
FR. REFLUX PUMPS
57-304-12 HOT OIL HDR. RETURN
MF-8
58-30-12 HOT OIL HDR. SUPPLY
MF-8
MF-2

Flow Diagrams
Unit 2

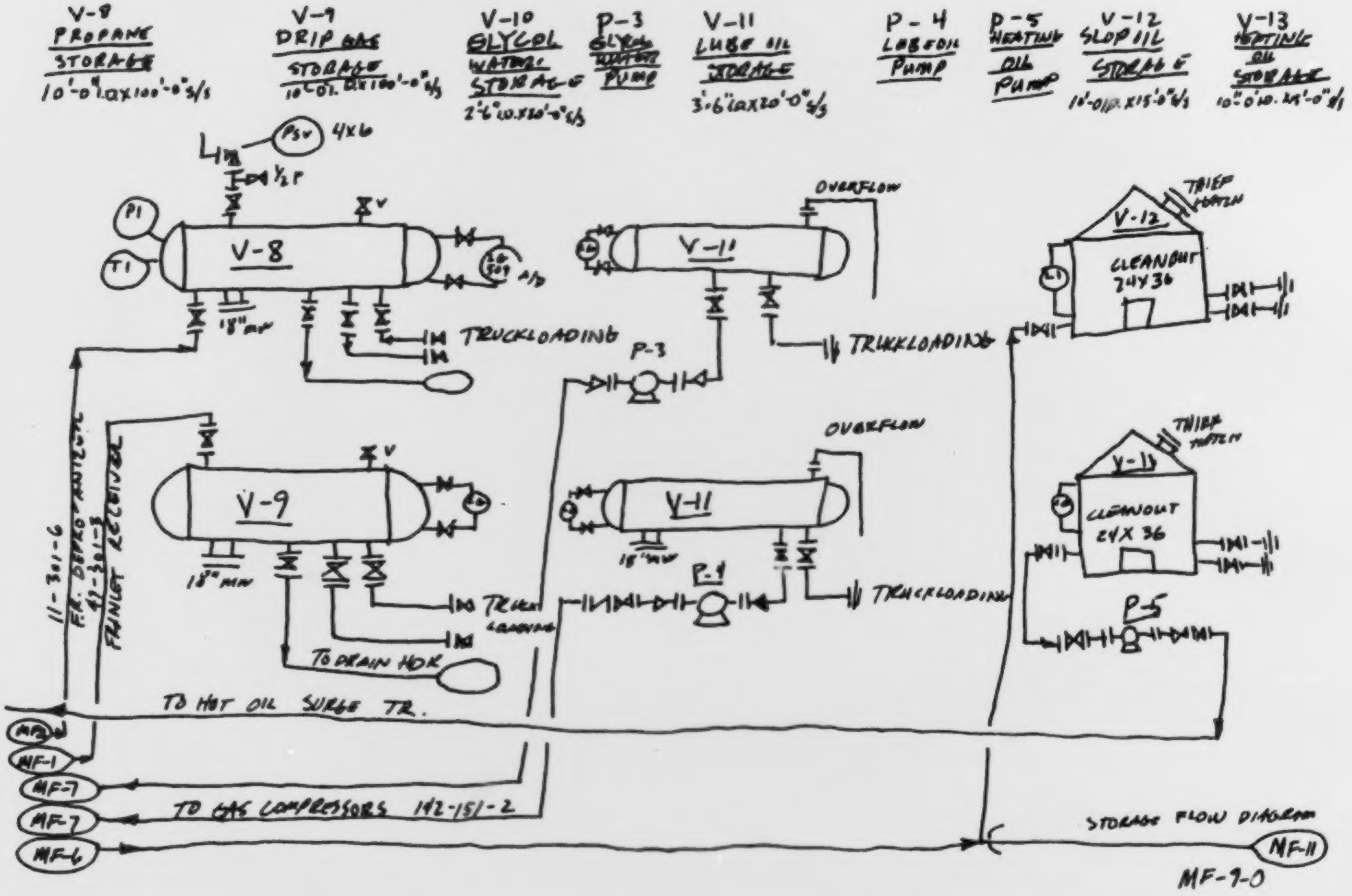
Assignment Sheet 5—Draw a Mechanical Flow DiagramWith Storage Facilities

Name ______________________________ Overall Rating __________

Evaluation criteria	Rating
Equipment symbols drawn to correct proportions	______
Correct ANSI symbols used	______
Equipment symbols correctly tagged	______
Lines correctly labeled	______
Title block filled out correctly	______
Drawing correctly plotted	______
Drawing correctly stored	______

Instructions: Given an engineers sketch, use CAD software to draw, plot, and store the drawing. Make special effort to ensure that each vessel and line is correctly noted and tagged. Be sure to note on each updated drawing that the CAD drawing is a revision of a current drawing. Use a separate layer for equipment, tags, lines, border and title block. Store the drawing named SC-103 to a diskette under a FLOW subdirectory.

Assignment Sheet 5


V-8
PROPANE
STORAGE
10'-0" I.D. x 100'-0" S/S
V-9
DRIP GAS
STORAGE
10'-0" I.D. x 100'-0" S/S
V-10
GLYCOL
WATER
STORAGE
2'-6" I.D. x 20'-0" S/S
P-3
GLYCOL
WATER
PUMP
V-11
LUBE OIL
STORAGE
3'-6" I.D. x 20'-0" S/S
P-4
LUBE OIL
PUMP
P-5
HEATING
OIL
PUMP
V-12
SLOP OIL
STORAGE
10'-0" I.D. x 15'-0" S/S
V-13
HEATING
OIL
STORAGE
10'-0" I.D. x 15'-0" S/S
PSV
4x6
1/2"
PI
TI
V-8
V
LG
18" MW
TRUCKLOADING
P-3
V-11
OVERFLOW
TRUCKLOADING
V-12
THIEF HATCH
LI
CLEANOUT
24X36
V-9
V
18" MW
TRUCK LOADING
TO DRAIN HDR
V-11
OVERFLOW
18" MW
P-4
TRUCKLOADING
V-13
THIEF HATCH
CLEANOUT
24X36
P-5
11-301-6
FR. DEPROPANIZER
12-301-8
FR. INLET RECEIVER
TO HOT OIL SURGE TK.
MF-10
MF-1
MF-7
MF-7
MF-6
TO GAS COMPRESSORS 142-151-2
STORAGE FLOW DIAGRAM
MF-11
MF-9-0

Flow Diagrams
Unit 2

Assignment Sheet 3—Draw Instrumentation and Electrical Symbols

Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Symbols drawn to correct proportions	_____
Correct ANSI symbols used	_____
Symbols correctly named	_____
Symbols correctly stored	_____

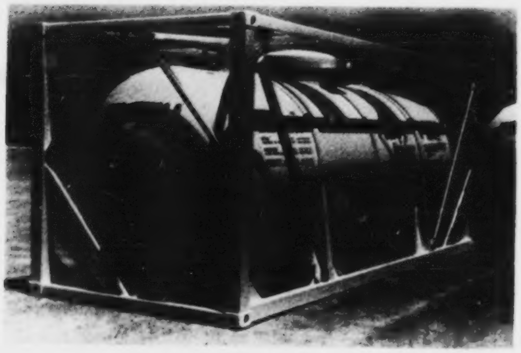
Instructions: Draw the symbols to the appropriate proportions. Name each drawing as indicated and save to ______\SYM directory. Place each drawing with the 180 degree quadrant at location 0,0, and omit any pipe line hook-ups. Attach attributes to each symbol to be Invisible:N, Constant:N, Verify:N, Preset:N.

Procedure

Attributes:	Tag: INSTR	Prompt: Type of instrument?	Default: XXX
	Tag: NUM	Prompt: Number of instrument?	Default: XXX

Height of each attribute to be .125
Center the INSTR attribute in the upper half of each symbol.
Center the NUM attribute in the lower half of each symbol.

1. Locally mounted instrument Name: LTAG
2. Control room mounted instrument Name: CTAG
3. Field board mounted instrument Name: FTAG
4. Mounted behind board instrument Name: HTAG



Pipe and Pipe Components
Unit 3

Objective Sheet

Unit Objective

After completing this unit, the student should be able to draw single and double line pipe symbols, and draw single and double line pipe drawings to scale. The student should demonstrate these competencies by completing the assignment sheets and by scoring minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to pipe and pipe components with their correct definitions.
2. Match types of metallic pipe materials with their applications.
3. Complete statements about nonmetallic pipes and their applications.
4. Match types of pipes with their manufacturing methods.
5. Match pipe end preparations with their characteristics and uses.
6. Select true statements about how to reference and specify pipe sizes and dimensions.
7. Identify types of flanges.
8. Match types of flange facings with their characteristics.
9. Match types of gaskets with gasket materials.
10. Select true statements about flange bolting requirements.
11. Complete a chart of welded fitting and flange symbols.

Objective Sheet

12. Complete a chart of threaded symbols.

13. Solve problems about guidelines for drawing pipe.

14. Select true statements about guidelines for drawing pipe components.

15. Look up fitting dimensions and draw symbols. (Assignment Sheet 1)

16. Construct single line drawings of screwed and socket weld pipe fittings. (Assignment Sheet 2)

17. Construct single line drawings of welded pipe fittings. (Assignment Sheet 3)

18. Construct double line drawings of welded pipe fittings. (Assignment Sheet 4)

19. Complete dimensions for single line drawings of butt weld and screwed fittings. (Assignment Sheet 5)

Pipe and Pipe Components
Unit 3

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan for enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from the transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Pipe Fitting Connections (Objective 4)
   TM 2—Special Bonnet Weld Fittings (Objective 4)
   TM 3—Types of Flanges (Objective 6)
   TM 4—Types of Flanges (Continued) (Objective 6)
   TM 5—Special Flanges (Objective 6)
   TM 6—Flange Facings (Objective 7)
   TM 7—Types of Gaskets (Objective 8)
   TM 8—Drawing Welded Pipe Components (Objective 12)
   TM 9—Drawing Threaded Pipe Components (Objective 12)
   TM 10—Dimensioning Single Line Piping (Objective 12)
   TM 11—Dimensioning Double Line Piping (Objective 12)

5. Develop teaching plan. Adjust for different learning styles.

6. Make copies of Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.

8. Discuss unit and specific objectives.

9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.

Suggested Activities

10. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Be sure to make transparencies from the transparency masters provided with this unit. These serve to reinforce specific objectives. Review the TMs and try to get samples of the items they display. Permit students to examine samples as you discuss the objectives and show the TMs. Skill areas: **Learning skills, learning to learn.**

2. When teaching Objectives 6, 7, and 8, have available samples from local industries of the variety of pipes used and the applications for which they are used. Impress upon students that pipe material selected and type of pipe selected is determined by specifications for the application. Skill areas: **Basic skills, listening.**

3. Stress throughout this unit that piping symbols need to be drawn to scale. Many symbols remain the same as symbols used in schematics, but the difference is that components must now be drawn to scale, and actual dimensions used. **Basic skills, listening.**

Suggested Activities

Resources Used in Developing This Unit

1. *ANSI/ASME Z32.2.3-1949 (R1988), Graphical Symbols for Pipe Fittings, Valves, and Piping.* New York: American National Standards Institute, 1988.

2. *ANSI Y32.11-1961 (R1985), Graphic Symbols for Flow Diagrams in the Petroleum and Chemical Industries.* New York: American National Standards Institute, 1961 Reaffirmed 1985.

3. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

4. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division, McGraw Hill Book Company, 1981.

5. *Publication AC11RM, AutoCAD Reference Manual.* New York: Autodesk Inc., 1990.

6. Weaver, Rip. *Process Pipe Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Supplemental Resources

1. Weaver, Rip. Video Tape Series, Process Pipe Drafting, Piping Familiarization, Piping Pointers, and Blueprint Reading Basics. Gulf Publishing Company, Book Division, P.O. Box 2608, Houston, TX 77252-2608.

2. Cadpipe Ortho, Iso, P&ID Forms, Software Package, Digitizer Driven. Endeco Engineering Ltd., 200 Carnegie Drive, St. Albert, Alberta T8N 5A7 CANADA. Phone: (403) 459-9041.

3. Pro-Pipe, Software Package, Isometric pipe drafting package. Industrial Graphics, P.O. Box 509, Branch, MI 49402. Phone: (616) 989-2701.

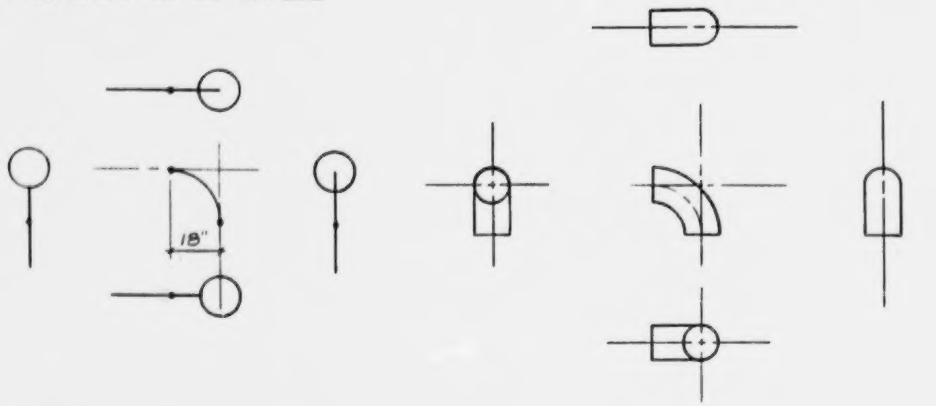
4. Piping Schematic Symbols Library. Drafting Technology Services, 2425 Nowata Place, Suite 202, Bartlesville, OK 74006. Phone (981) 335-2480.

Pipe and Pipe Components
Unit 3

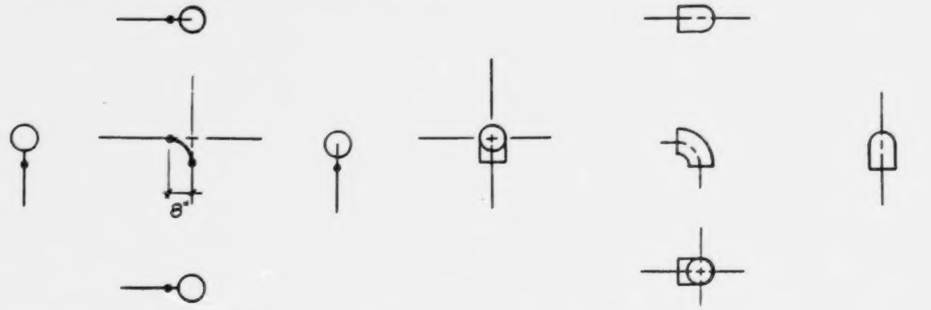
Answers to Assignment Sheets

Assignment Sheet 1

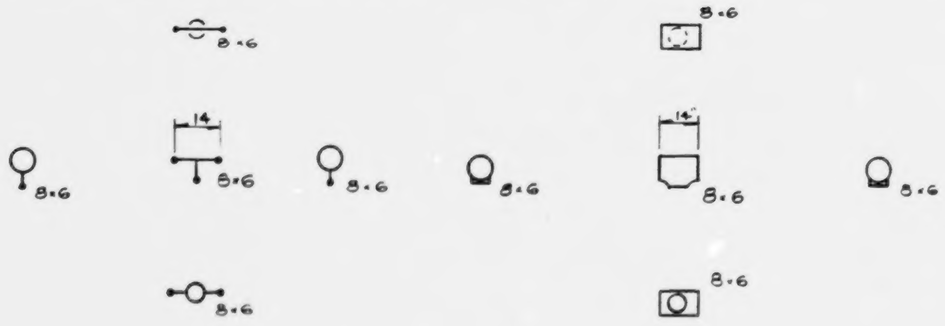
Problem A: 12″ 90° LR ELL



Problem B: 8″ 90° SR WELD ELL

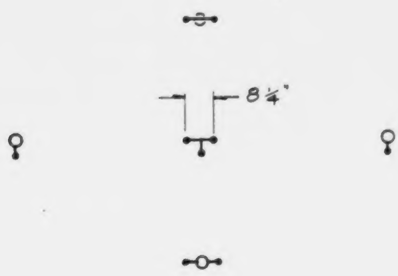


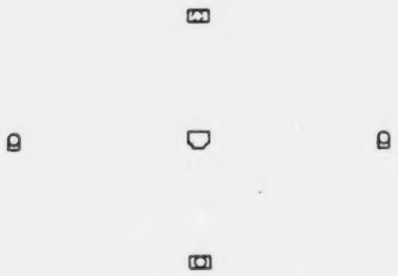
Problem C: 8″ × 6″ STD WT WELD REDUCING TEE


8•6
8•6
14
14″
8•6
8•6
8•6
8•6
8•6
8•6
8•6
8•6
8•6

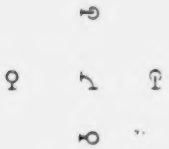
Answers to Assignment Sheets

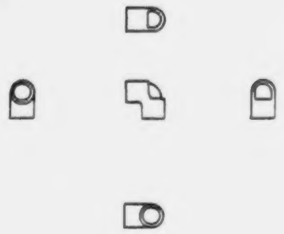
Problem D: 4″ STD WT WELD TEE



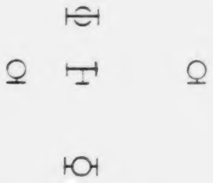


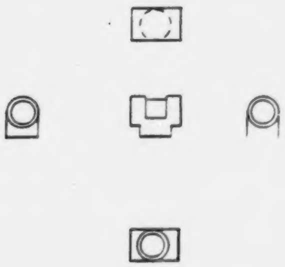
Problem D: 2″ 2,000# THREADED ELBOW LR



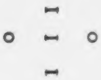


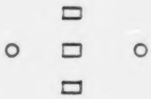
Problem F: 3″ 6,000# THREADED TEE





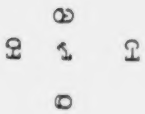
Problem G: 3,000# THREADED COUPLING

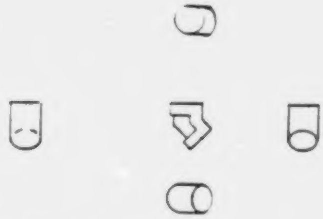




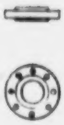
Answers to Assignment Sheets

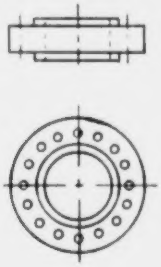
Problem H: 3″ 2,000# SOCKET WELD 45° ELBOW



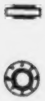


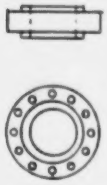
Problem I: 10″ 600# SLIP ON WELDING FLANGE



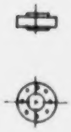


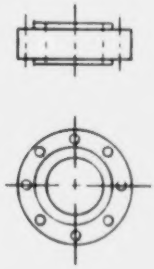
Problem J: 6″ 300# SLIP ON WELDING FLANGE





Problem K: 8″ 150# WIN FLG

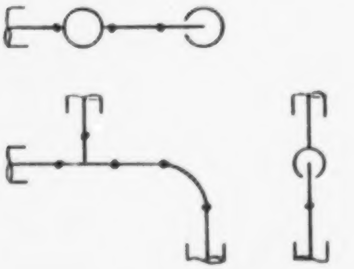




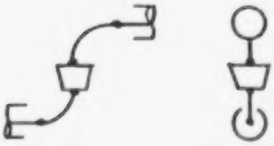
Answers to Assignment Sheets

Assignment Sheet 2

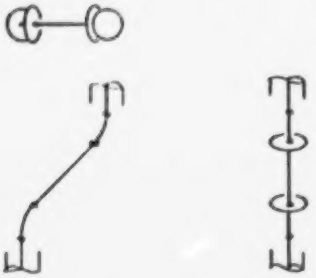
A.



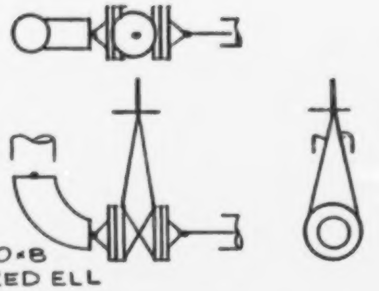
B.



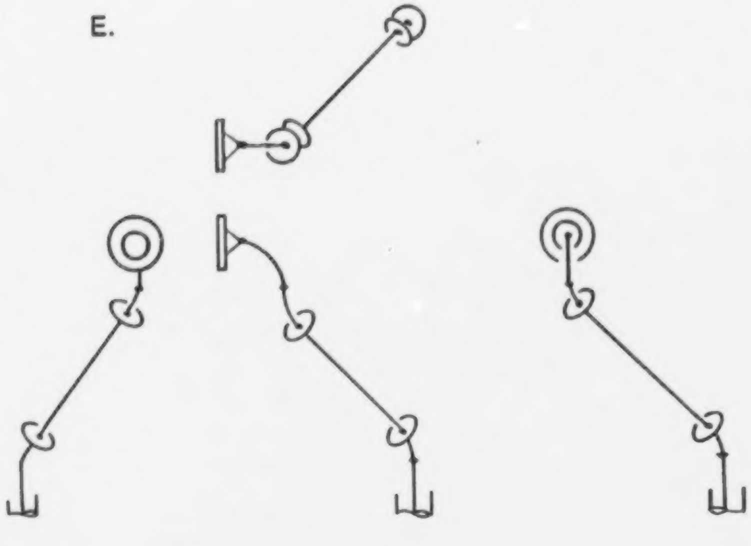
C.



D.



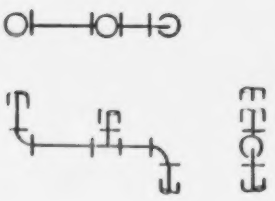
E.



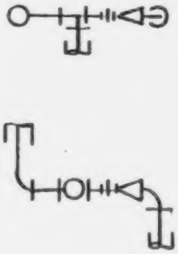
Answers to Assignment Sheets

Assignment Sheet 3

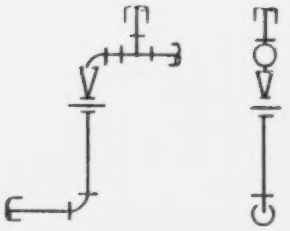
A.



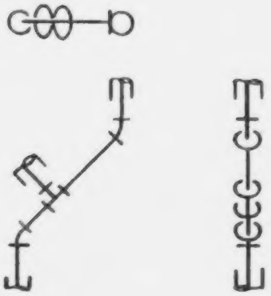
B.



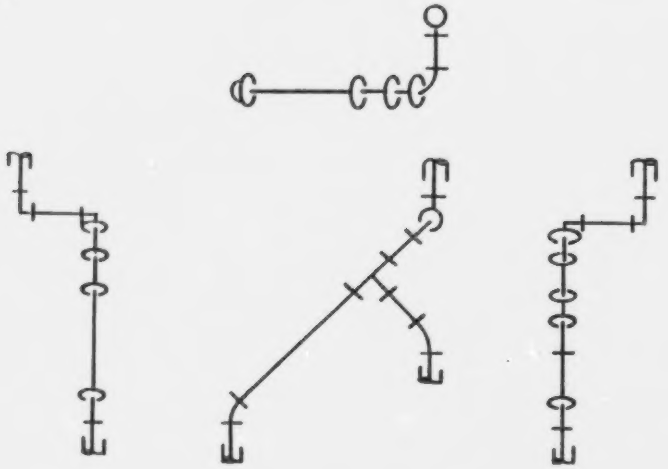
C.



D.



E.



Asnwers to Assignment Sheets

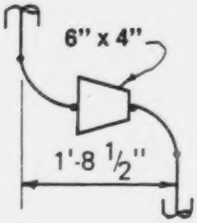
Assignment Sheet 4

Evaluate according to criteria written in the assignment sheet.

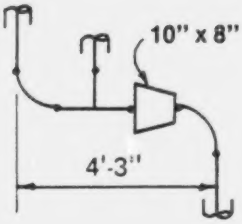
Assignment Sheet 5

A.

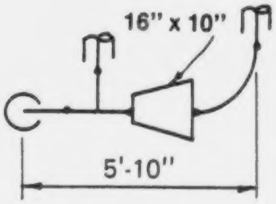
1.



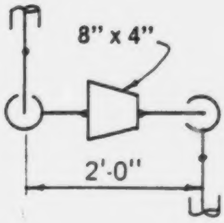
2.



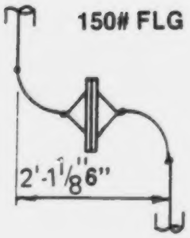
3.



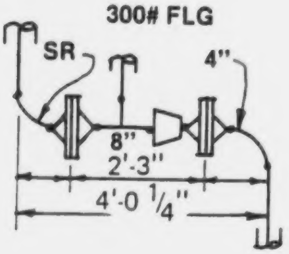
4.



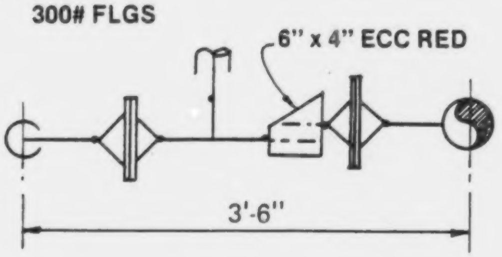
5.


150# FLG
2'-1 1/8"
6"

6.


300# FLG
SR
4"
8"
2'-3"
4'-0 1/4"

7.

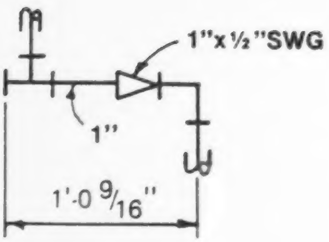

300# FLGS
6" x 4" ECC RED
3'-6"

Answers to Assignment Sheets

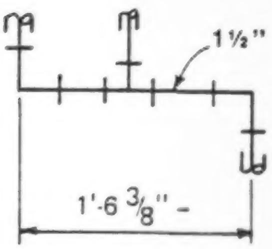
Assignment Sheet 5

B

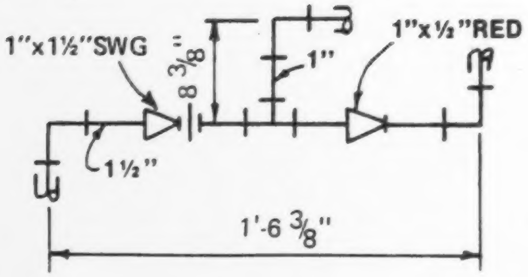
1.


1"x½"SWG
1"
1'-0 9/16"

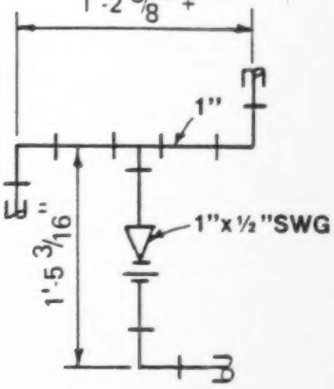
2.



3.


1"x1½"SWG
8 3/8"
1"
1"x½"RED
1½"
1'-6 3/8"

4.


1'-2 3/8" +
1"
1"x½"SWG
1'-5 3/16"

Pipe and Pipe Components
Unit 3

Answers to Written Test

1. a. 4
   b. 9
   c. 7
   d. 10
   e. 2
   f. 6
   g. 3
   h. 1
   i. 5
   j. 8

2. a. 3
   b. 5
   c. 1
   d. 2
   e. 4

3. a. Plactic
   b. Exotic

4. a. 3
   b. 4
   c. 1
   d. 2

5. a. 4
   b. 6
   c. 3
   d. 8
   e. 1
   f. 5
   g. 7
   h. 2

6. a, d, e

7. a. Weld neck flange
   b. Reducing flange
   c. Lap flange
   d. Blind flange
   e. Slip-on flange
   f. Socket weld flange

8. a. 5
   b. 3
   c. 2
   d. 1
   e. 4

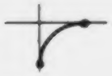
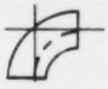
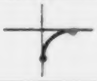
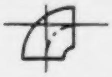
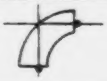
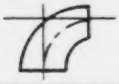
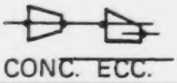
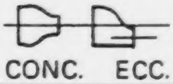
9. a. 3
   b. 4
   c. 1
   d. 6
   e. 5
   f. 2

10. a. Equal groups
    b. Centerlines
    c. Pressure
    d. Service conditions

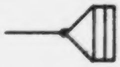
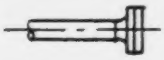
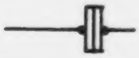
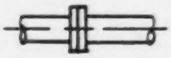
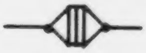
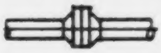
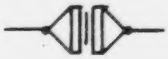
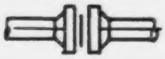
Answers to Written Test

11\.

a. Fittings

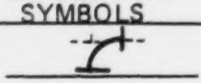
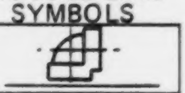
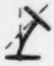
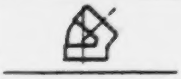
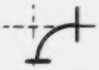
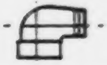
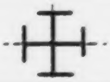
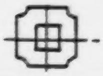
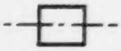
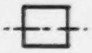
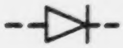
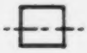
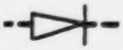
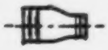
	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1) Elbow, 90° long radius		
2) Elbow, 90° short radius		
3) Elbow, reducing, 90° long radius		
4. Reducers, concentric and eccentric		

b. Flanges

1) Blind		
2) Slip-on		
3) Weld neck		
4) Orifice		

Answers to Written Test

12.

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
a. Elbow, 90°		
b. Elbow, 45°		
c. Elbow, Street		
d. Cross		
e. Coupling, Full		
f. Reducer		
g. Swaged Nipple		

13. a. (2)
    b. (2)

14. a, b, e

Pipe and Pipe Components
Unit 3

Written Test

Name ______________________________ Score ______________

1. Match the terms on the right with their correct definitions.

______a. A metal composed of two or more metals

______b. A solid, plate-like fitting used to seal the end of a line

______c. A metal fitting welded to straight pipe to make a tee, cross, or side outlet

______d. Standardized fittings and valves used to assemble a piping system

______e. Any type of pipe connector used to change size or direction, or to make a connection

______f. Pipe coated with molten zinc to retard corrosion

______g. Any pipe less than 12″ in length that can be threaded or welded

______h. The approximate inside diameter of pipe 1/8″ to 12″, and the outside diameter of pipe 14″ and larger

______i. ANSI numbers assigned to designate pipe wall thickness such as 2″ schedule 40 pipe has a .154 wall and 2″ schedule 80 has a .218 wall

______j. Round, tubular products that are not made in standard pipe sizes

1. Nominal pipe size
2. Fitting
3. Nipple
4. Alloy
5. Schedule numbers
6. Galvanized
7. Bonnet
8. Tubing
9. Blind flange
10. Components

Written Test

2. Match types of metallic pipe materials with their applications. Place the number beside the material type in the blank beside the description of the application.

______a. Used for water, oil, and gas service

______b. Used in applications that require corrosion resistance

______c. Used for sewage and low-pressure applications

______d. Used for short connections and small diameter applications

______e. Used for handling special chemicals, abrasive materials, or highly corrosive materials

1. Cast iron
2. Brass and copper
3. Wrought iron and steel
4. Lead, aluminum, stainless, and alloys
5. Galvanized steel

3. Complete statements about nonmetallic pipes and their applications. Circle the material that best completes each of the following statements.

   a. Nonmetallic pipes may be made from (**high-density foil**) (**plastic**), glass, clay, or rosin and fibers.

   b. Engineers specify nonmetallic pipes for use in (**exotic**) (**common**) applications such as labs and hospitals.

4. Match types of pipes with their manufacturing methods. Place the number beside the type of pipe in the blank beside the description of the manufacturing method.

______a. Made from solid metal pieces called billets that are conditioned, heated, and pierced to form a hollow tube

______b. Made from a coil of flat metal that is heated, formed, and then sealed with mechanical pressure as it is joined with a butt joint forge welding process

______c. Made from a coil of flat metal that is formed and then sealed with a high frequency fusion welding process

______d. Large pipe sizes made from plae that is formed on special presses and then joined with a special arc welding process

1. Electric weld pipe
2. Double submerged arc weld pipe
3. Seamless pipe
4. Continuous weld pipe

Written Test

5. Match pipe end preparations with their characteristics and uses. Place the number beside the type of end preparation in the blank that describes its uses or characteristics.

______a. To weld to a fitting or another length of pipe

______b. Not easy to disassemble, but otherwise safer and more economical than a flanged joint, and the smoother surface makes it easy to insulate and form a leakproof connection

______c. Screwed or welded onto the ends of pipe to make a system easy to disassemble

______d. Easy to assemble and disassemble, economical because no welding is required, but heavier than welded connections so expense is added for supporting a line

______e. For systems designed with screwed connections with pipes under 2 1/2" used on low-temperature or low-pressure installations

______f. Easy to assemble and disassemble, but cut threads reduce wall thickness and increases the chance of failure

______g. For systems designed for socket weld or bell and spigot, or with soldered connections

______h. Socket welds designed for high pressures from 2,000 to 6,000 psi, and bell and spigot designed for low-pressure drainage systems

1. Threaded use
2. Plain end characteristics
3. Flanged use
4. Beveled use
5. Threaded characteristics
6. Beveled characteristics
7. Plain end use
8. Flanged characteristics

Written Test

6. Select true statements about how to reference and specify pipe sizes and dimensions. Place an "X" beside each true statement.

______a. Reference pipe by its nominal size.

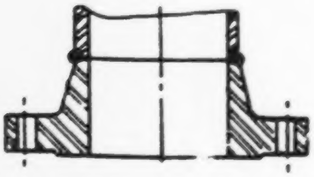
______b. Reference the ID of pipe with a diameter over 14".

______c. Reference the OD of pipe with a diameter under 14".

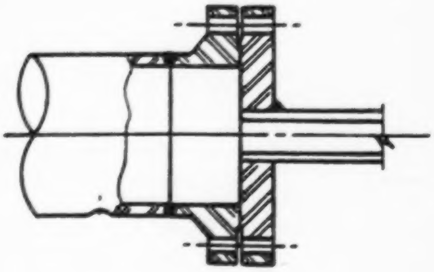
______d. Specify pipes to take advantage of how pipe is usually supplied: random lengths from 16 to 22 feet.

______e. Specify special sizes to reflect manufactured sizes: 36 to 40 feet.

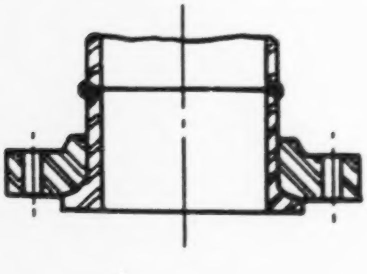
7. Identify types of flanges



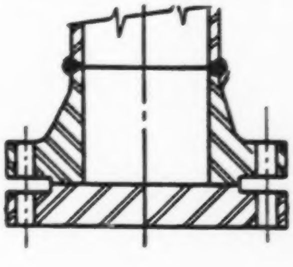
a. ____________________



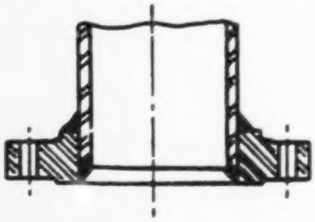
b. ____________________



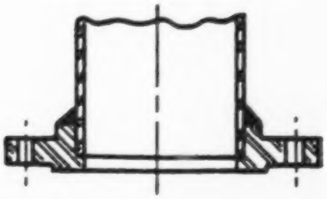
c. ____________________



d. ____________________



e. ____________________



f. ____________________

Written Test

8. Match types of flange facings on the right with their characteristics.

______a. Machine tool finished with concentric grooves; generally used with soft flat ring gaskets

______b. Used with 125# and 250# cast iron valves and fittings that permit using a flat gasket whose outer diameter equals that of the flange

______c. Used where the outer diameter of the female face acts to locate and retain the gasket

______d. The innder and outer groove diameters provide a minimum area for retaining and compressing the flat gasket, thus resulting in a minimum bolting load

______e. A flat bottom groove in a flange that uses an octagonal or oval cross-section shaped metal ring gasket and must match a similar flange facing

1. Tongue and Groove face
2. Make and female face
3. Flat face
4. Ring joint face
5. Raised face

9. Match types of gaskets with gasket materials. Place the number beside the gasket type in the blank beside the description of its materials.

______a. Made of paper, cloth, rubber, compressed asbestos, ingot iron, copper, aluminum, and other various combinations of materials

______b. Concentric grooves machined into face of flat metal for use with smooth-finished flange face

______c. Made of metal and soft filler material, are suitable for about 100 degree higher temperatures than plain asbestos gaskets

______d. Available plain or asbestos filled, are not commonly used

1. Laminated
2. Joint sealant
3. Flat ring
4. Serrated
5. Ring joint
6. Corrugated

Written Test

______e. Made of softest carbon metal and available in octagonal or oval cross-section shapes for use in high temperature and corrosive conditions

______f. Made of low density Teflon in a cord from and used where conditions require a material with wide temperature range, no deterioration due to age, unaffected by chemicals, and no contamination to flow products

10. Complete statements about flange bolting standards. Circle the material that best completes each of the following statements.

    a. Bolt patterns come in (**twos, threes, and fours**) (**equal groups**).

    b. Bolt holes are spaced equally between (**centerline**) (**right angles**).

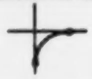
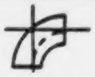
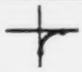
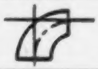
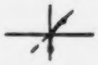
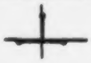
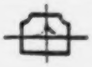
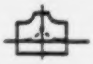
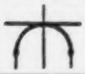
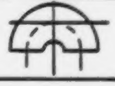
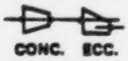
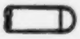
    c. Generally speaking, the higher the (**temperature**) (**pressure**), the greater the number of flange bolts required, and the larger the flange, the greater number of flange bolts required.

    d. The number of flange bolt holes required is related to (**company standards**) (**service conditions**) and other temperature and pressure standards set by ANSI.

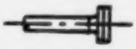
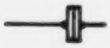
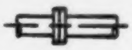
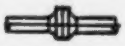
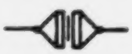
Written Test

11. Complete the following chart of welded fitting and flange symbols

a. Fittings

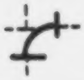
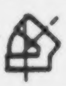
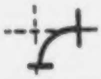
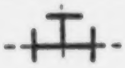
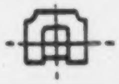
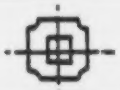
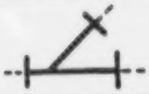
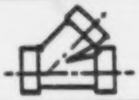
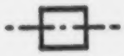
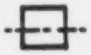
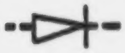
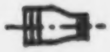
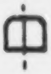
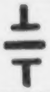
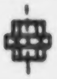
	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1.		
2. Elbow, 90° short radius		
3. Elbow, reducing, 90° long radius		
4. Elbow, 45° long radius		
5.		
6. Tee, reducing outlet		
7.		
8. Reducers, concentric and eccentric		
9. Cap		

b. Flanges

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1. Blind		
2.		
3. Weld neck		
4. Orifice		

Written Test

12. Complete the following chart of threaded fitting symbols

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
A. Elbow, 90°		
B. Elbow, 45°		
C. Elbow, Street		
D.		
E. Cross		
F.		
G. Coupling, Full		
H. Reducer		
I.		
J. Cap		
K.		

Written Test

13. Solve problems about guidelines for drawing pipe. Circle the number beside the statement that best solves each of the following problems.

    a. You have been assigned a drafting project that is going to use pipe that is more than 12" in diameter. You know that pipe that large should be drawn with double lines, but just to be sure, you should:

        (1) Check all engineering specs.

        (2) Check company standards for drawing pipe.

        (3) Try to find the ANSI standard that covers pipe drawing.

    b. You are working with a drawing that has 6" pipe in runs long enough that you will have to have pipe breaks. You must decide whether to make the ODs on the pipe breaks to scale, so you should follow the rule that:

        (1) All ODs on any size pipe break have to be drawn to scale.

        (2) ODs on pipe breaks more than 2" should be drawn to scale.

        (3) ODs on pipe breaks more than 12" should be drawn to scale.

14. Select true statements about guidelines for drawing pipe components. Place an "X" beside each true statement.

______a. Whether it's single line or double line pipe drafting, always construct the pipe size and welded fittings to scale.

______b. In views turned toward or turned away from the viewer, construct nominal pipe size and welded fittings' OD to scale.

______c. Construct the radius of long radius elbows equal to the nominal pipe size.

______d. Construct the radius of short radius elbows 1 1/2 times the nominal pipe size.

______e. Construct the radius of 45° elbows 1 1/2 times the nomial pipe size.

______f. Construct all reducing fittings with single lines.

***Permission to duplicate this test is granted.**

Pipe and Pipe Components
Unit 3

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assigment Sheet 1—Look Up Fitting Dimensions and Draw Symbols Rating ______

Comments: ______________________________________

____

Assignment Sheet 2—Construct Single Line Drawings of Screwed and Socket Weld Pipe Fittings Rating ______

Comments: ______________________________________

____

Assignment Sheet 3—Construct Single Line Drawings of Welded Pipe Fittings Rating ______

Comments: ______________________________________

____

Assignment Sheet 4—Construct Double Line Drawings of Welded Pipe Fittings Rating ______

Comments: ______________________________________

____

Assignment Sheet 5—Complete Dimensions for Single Line Drawings of Butt Weld and Screwed Fittings Rating ______

Comments: ______________________________________

____

Unit Evaluation Form

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ____

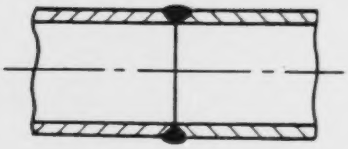
____

Teacher Signature ______________________________ Date ____________

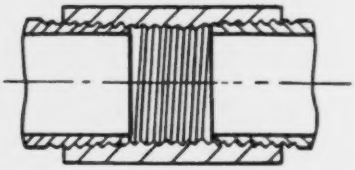
Student Signature ______________________________ Date ____________

*Permission to duplicate this form is granted.

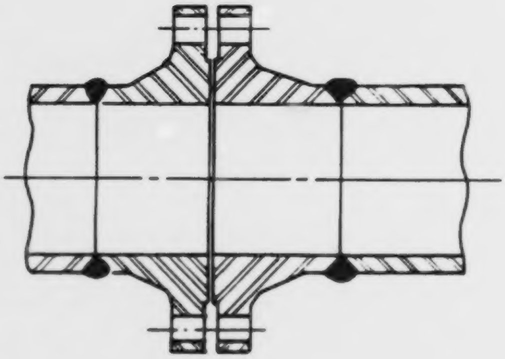
Pipe Fitting Connections



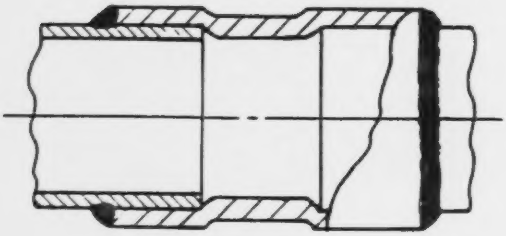
Butt Weld



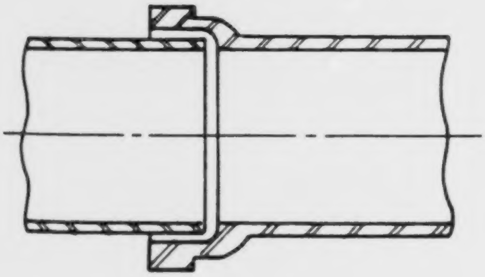
Threaded



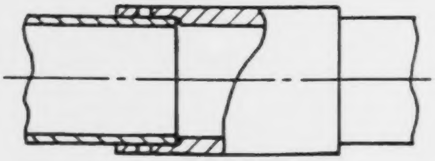
Flanged



Socket Weld

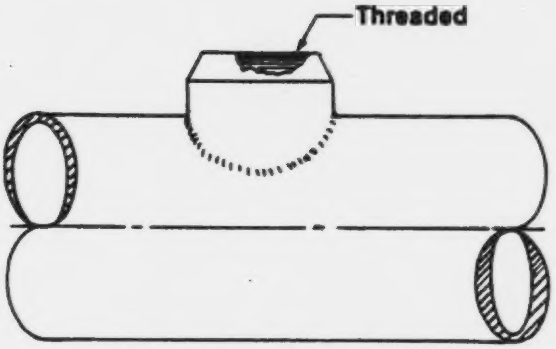


Bell and Spigot

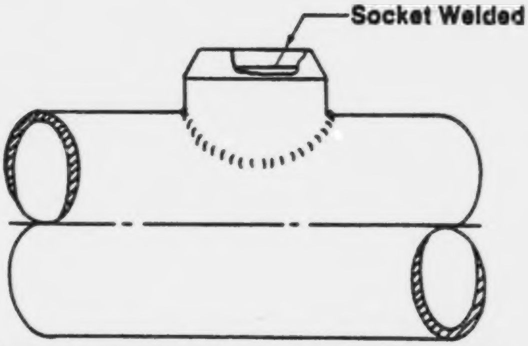


Soldered

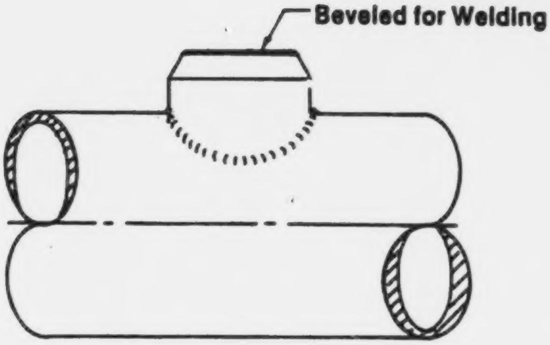
Special Bonnet Weld Fittings



Threaded Outlet
(Threadolet)

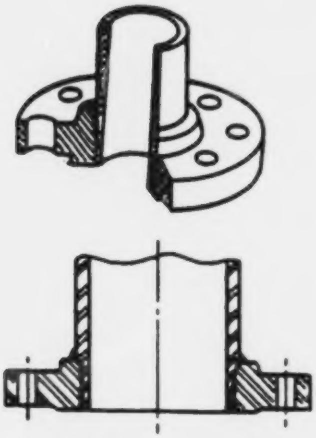

Socket Welded

Socket Outlet (Sockolet)

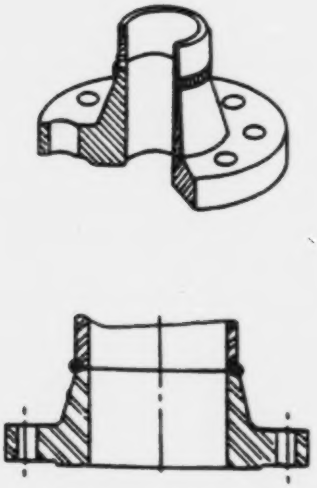

Beveled for Welding

Welding Outlet
(Weldolet)

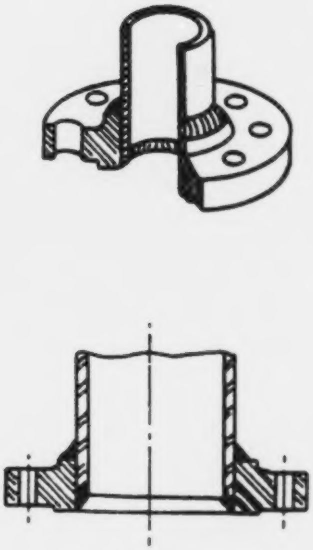
Types of Flanges



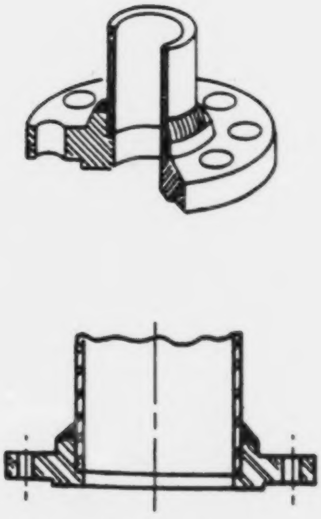
Screwed



Weld Neck

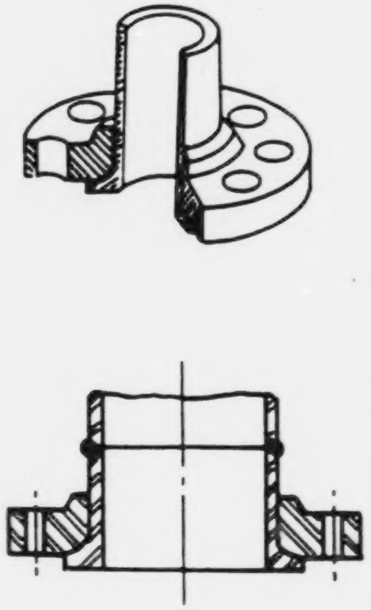


Slip-on

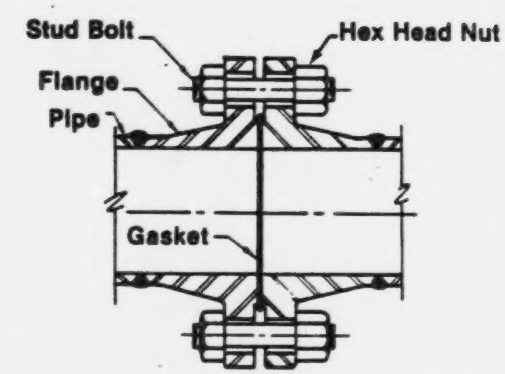


Socket Weld

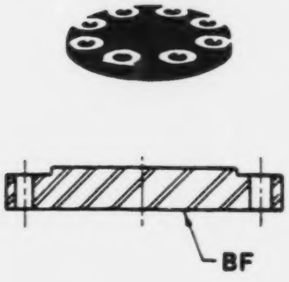
Types of Flanges
(Continued)



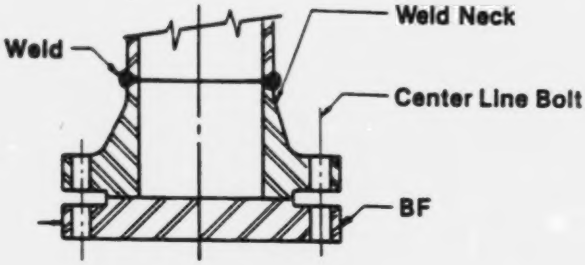
Lap


Stud Bolt
Hex Head Nut
Flange
Pipe
Gasket

Flange Fit-up Procedure



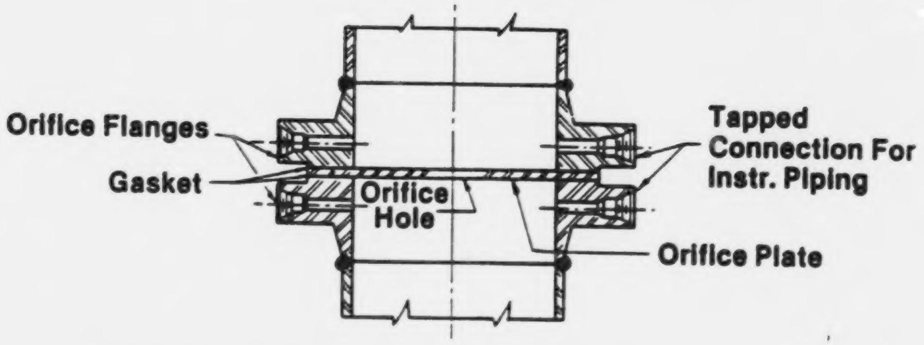
Section Thru Blind Flanges


Weld
Weld Neck
Center Line Bolt
BF

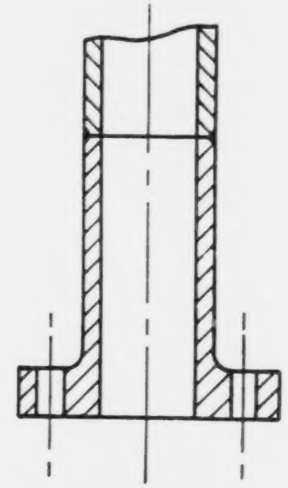
Blind Flange Assembly

Blind

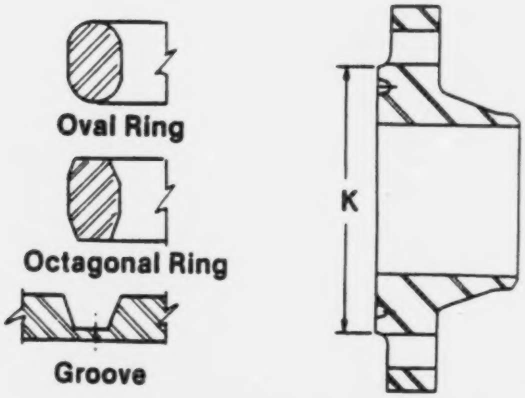
Special Flanges


Orifice Flanges
Gasket
Orifice Hole
Tapped Connection For Instr. Piping
Orifice Plate

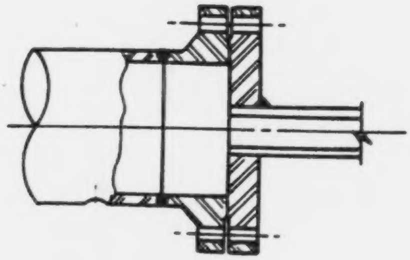
Orifice Flanges — Used in Pairs



Long Neck Flange

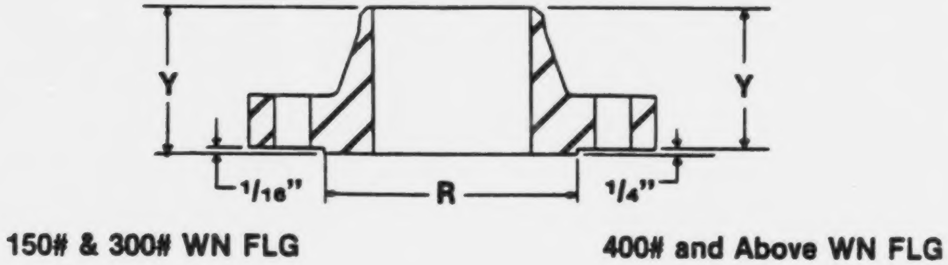

Oval Ring
Octagonal Ring
Groove
K

Ring-Type Joint Flange

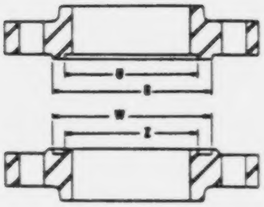


Reducing Flange

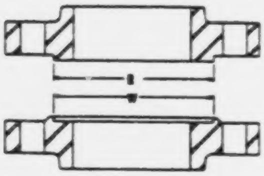
Flange Facings


Y
Y
1/16"
R
1/4"
150# & 300# WN FLG
400# and Above WN FLG

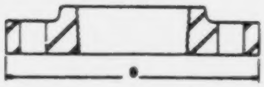
Raised Face



Tongue and Groove
Face

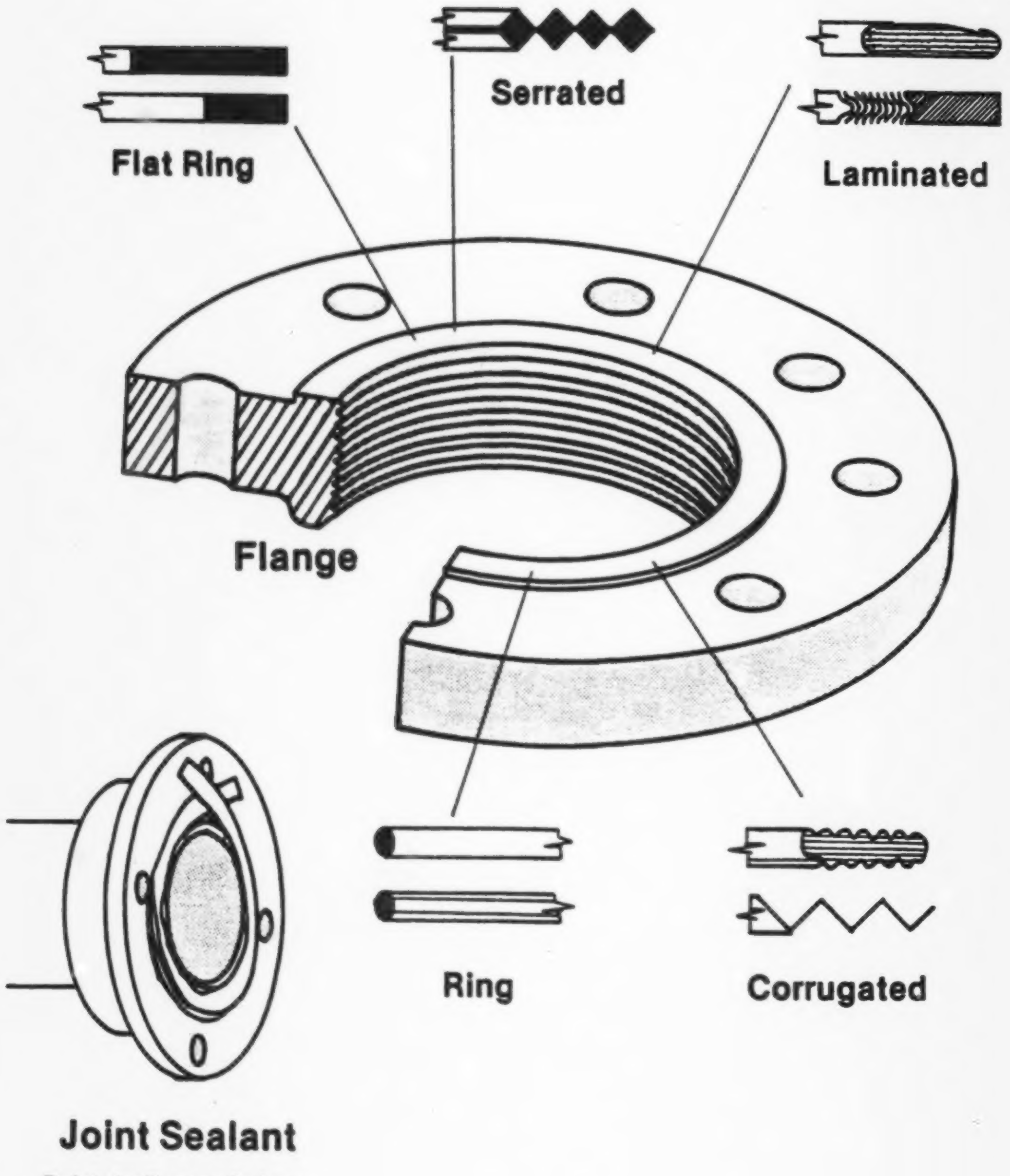


Male and Female
Face

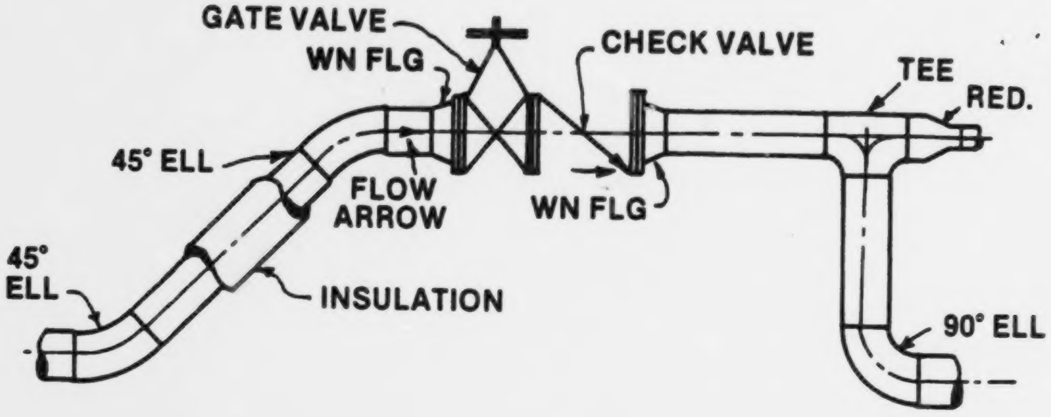


Flat Face

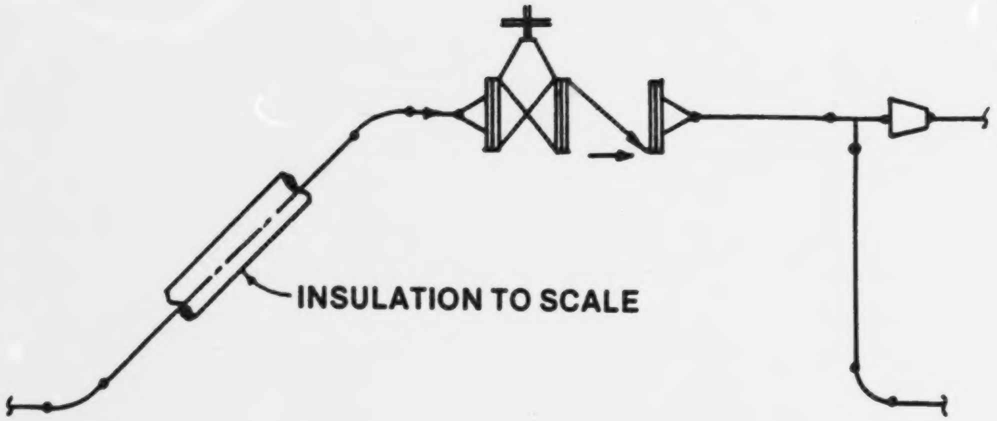
Types of Gaskets


Flat Ring
Serrated
Laminated
Flange
Ring
Corrugated
Joint Sealant
Polytetrafluoroethylene

Drawing Welded Pipe Components

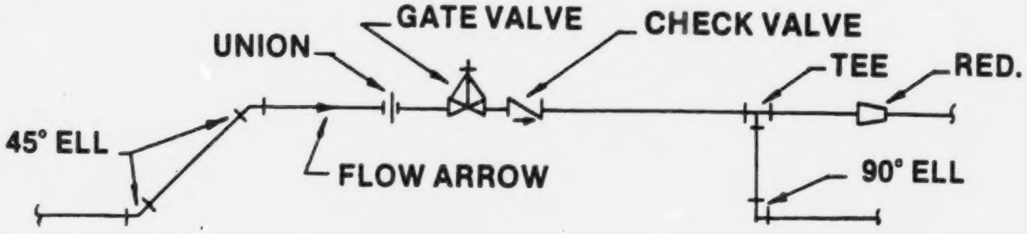

GATE VALVE
WN FLG
CHECK VALVE
TEE
RED.
45° ELL
FLOW ARROW
WN FLG
45° ELL
INSULATION
90° ELL

Double Line Butt Weld Pipe and Fittings


INSULATION TO SCALE

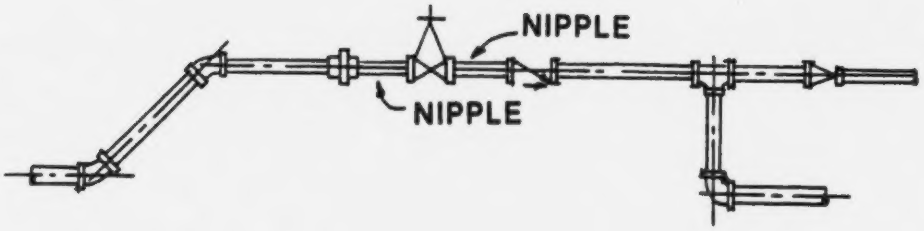
Single Line Butt Weld Pipe and Fittings

Drawing Threaded Pipe Components



GATE VALVE
UNION
CHECK VALVE
TEE
RED.
45° ELL
FLOW ARROW
90° ELL

Single Line Threaded Pipe

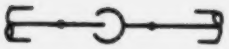


NIPPLE
NIPPLE

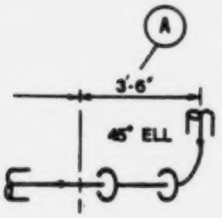
Double Line Threaded Pipe

(NOTE: Pipe 2" and above is usually drawn double line depending on company standards.)

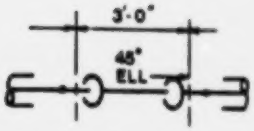
Dimensioning Piping—Single Line



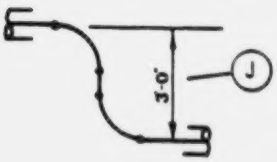
Plan



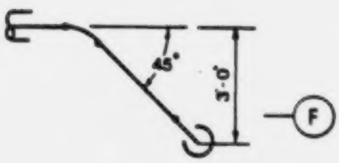
Plan



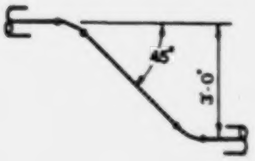
Plan



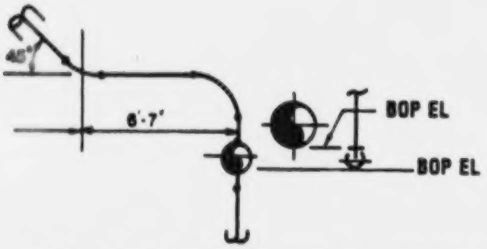
Elevation



Elevation

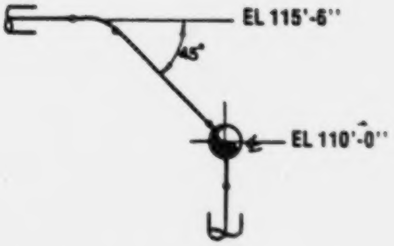


Elevation


45°
6'-7'
BOP EL
BOP EL

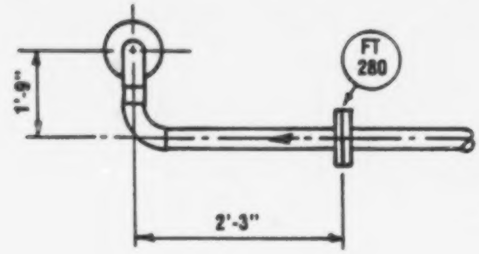
FOR MULTIPLE LINES OF VARIOUS SIZES USE BOP EL

Elevation

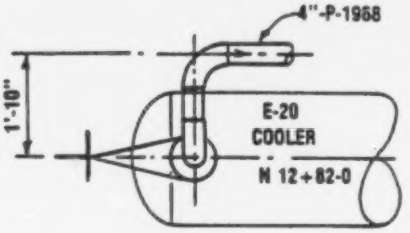

EL 115'-6"
45°
EL 110'-0"

Elevation

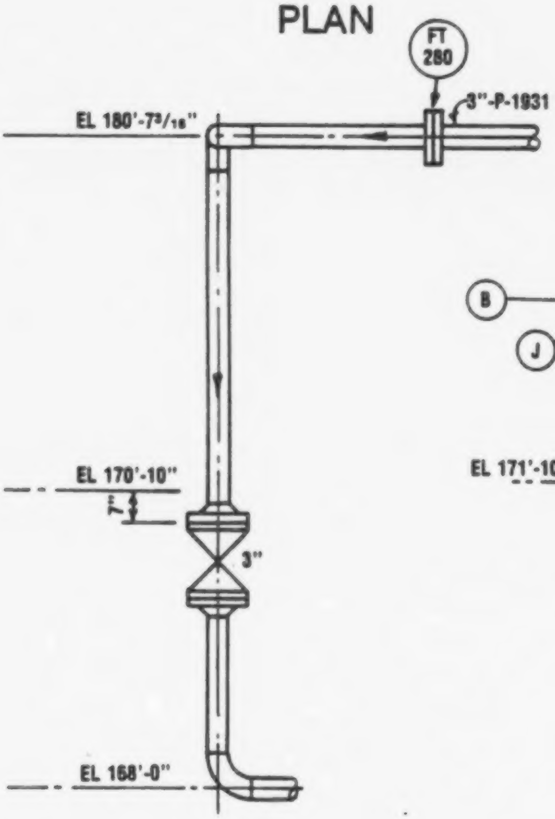
Dimensioning Piping—Double Line



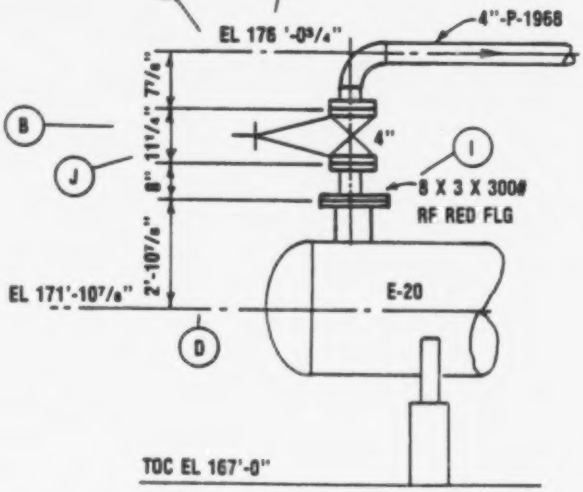
PLAN


4"-P-1968
1'-10"
E-20
COOLER
N 12+82-0

PLAN


FT 280
EL 180'-7 3/16"
3"-P-1931
EL 170'-10"
7"
3"
EL 168'-0"

ELEVATION


H
E
EL 176'-0 3/4"
4"-P-1968
7 7/8"
B
11 1/4"
4"
J
8"
I
8 X 3 X 300#
RF RED FLG
2'-10 7/8"
E-20
EL 171'-10 7/8"
D
TOC EL 167'-0"

ELEVATION

Pipe and Pipe Components
Unit 3

Information Sheet

1. **Terms and definitions**

   a. **Alloy** — A metal composed of two or more metals

   b. **Blind flange** — A solid, plate-like fitting used to seal the end of a line

   c. **Bonnet** — A metal fitting welded to straight pipe to make a tee, cross, or side outlet

   d. **Components** — Standardized fittings and valves used to assemble a piping system

   e. **Fitting** — Any type of pipe connector used to change size or direction, or to make a connection

   f. **Galvanized** — Pipe coated with molten zinc to retard corrosion

   g. **Nipple** — Any pipe less than 12″ in length that can be threaded or welded

   h. **Nominal pipe size** — The approximate inside diameter of pipe 1/8″ to 12″, and the outside diameter of pipe 14″ and larger

   i. **Schedule numbers** — ANSI numbers assigned to designate pipe wall thickness such as 2″ schedule 40 pipe has a .154 wall and 2″ schedule 80 has a .218 wall

   j. **Tubing** — Round, tubular products that are not made in standard pipe sizes

2. **Types of metallic pipe materials and their uses**

   a. **Wrought iron and steel** — Used for water, oil, and gas service

   b. **Galvanized steel** — Used in applications that require corrosion resistance

   c. **Cast iron** — Used for sewage and low-pressure applications

   d. **Brass and copper** — Used for short connections and small diameter applications

   e. **Lead, aluminum, stainless, and alloys** — Used for handling special chemicals, abrasive materials, or highly corrosive materials

Information Sheet

3. **Nonmetallic pipes and their applications**

   a. Nonmetallic pipes may be made from plastic, glass, clay, or rosin and fibers.

   b. Engineers specify nonmetallic pipes for use in exotic applications such as labs and hospitals.

4. **Types of pipes and their manufacturing methods**

   a. **Seamless pipe** — Made from solid metal pieces called billets that are conditioned, heated, and pierced to form a hollow tube

   b. **Continuous weld pipe** — Made from a coil of flat metal that is heated, formed, and then sealed with mechanical pressure as it is joined with a butt joint forge welding process

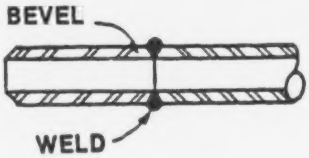
   c. **Electric weld pipe** — Made from a coil of flat metal that is formed and then sealed with a high frequency fusion welding process

   d. **Double submerged arc weld pipe** — Large pipe sizes made from plate that is formed on special presses and then joined with a special arc welding process

5. **Characteristics and uses of pipe end preparations**

   a. **Beveled** — To weld to a fitting or another length of pipe

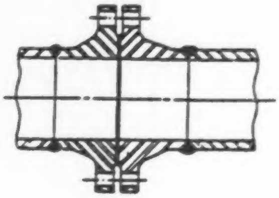
   b. **Beveled characterisitcs** — Not easy to disassemble, but otherwise safer and more economical than a flanged joint, and the smoother surface makes it easy to insulate and form a leakproof connection



   c. **Flanged use** — Screwed or welded onto the ends of pipe to make a system easy to disassemble

Information Sheet

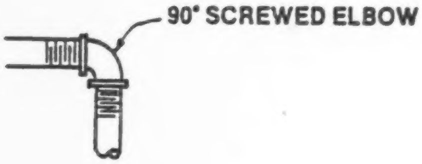
d. **Flanged characteristics** — Easy to assemble and disassemble, economical because no welding is required, but heavier than welded connections so expense is added for supporting a line

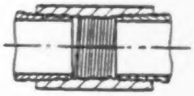


Flanged

e. **Threaded use** — For systems designed with screwed connections with pipes under 2 1/2″ used on low-temperature or low-pressure installations

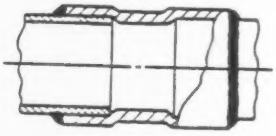
f. **Threaded characteristics** — Easy to assemble and disassemble, but cut threads reduce wall thickness and increases the chance of failure



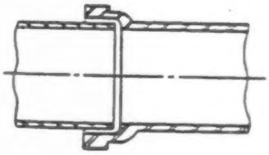


g. **Plain end use** — For systems designed for socket weld or bell and spigot, or with soldered connections

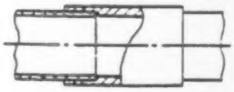
h. **Plain end characteristics** — Socket welds designed for high pressures from 2,000 to 6,000 psi, and bell and spigot designed for low-pressure drainage systems



Socket Weld



Bell and Spigot



Soldered

Information Sheet

6. How to reference and specify pipe sizes and dimensions

a. Reference pipe by its nominal size.

b. Reference the ID of pipe with a diameter under 14″.

c. Reference the OD of pipe with a diameter of 14″ or more.

Note: There are exceptions to the 14″ rule about ID and OD because some pipe schedules vary the ID and OD, but the variance should be indicated.

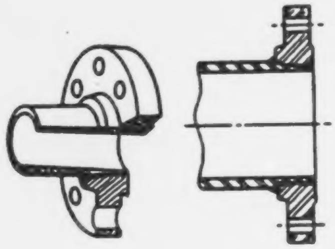
d. Specify pipes to take advantage of how pipe is usually supplied: random lengths from 16 to 22 feet.

Example: A 12′ piece of pipe would be cut from a 16′ random length, and a 20′ piece of pipe would be cut from a 22′ random length.

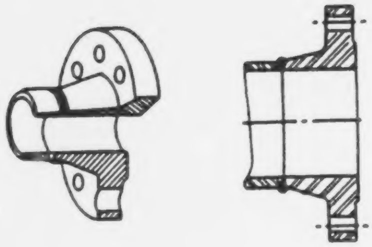
e. Specify special sizes to reflect manufactured sizes: 36 to 40 feet.

7. Types of flanges

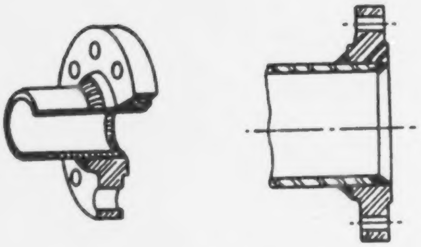
a. Screwed on flange



b. Weld neck flange

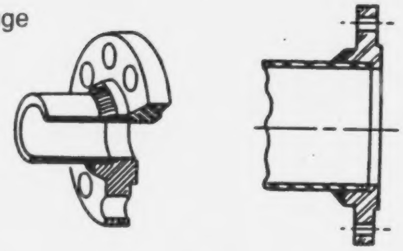


c. Slip-on flange

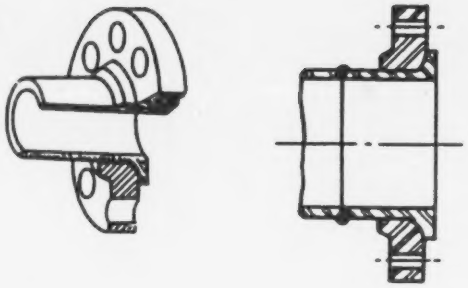


Information Sheet

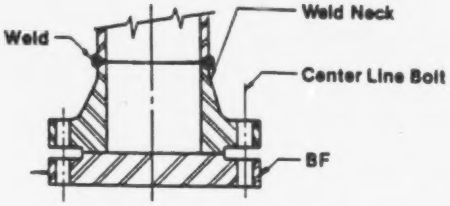
d. Socket weld flange



e. Lap flange



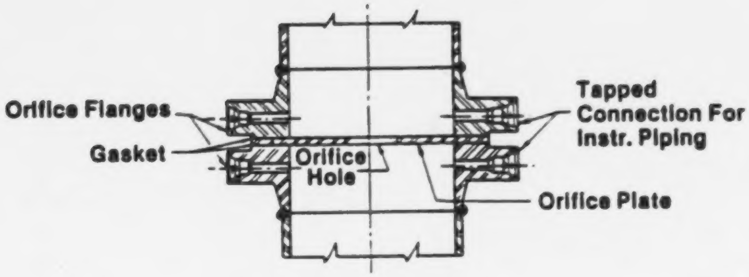
f. Blind flange


Weld
Weld Neck
Center Line Bolt
BF

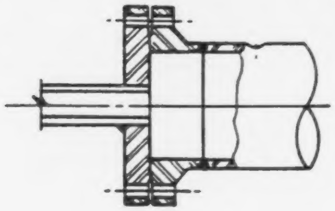
Information Sheet

g. Special flanges

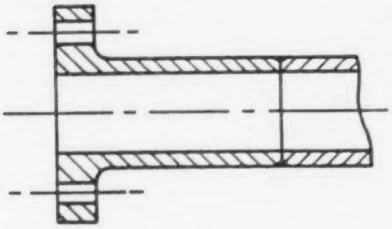
Orifice


Orifice Flanges
Gasket
Orifice Hole
Tapped Connection For Instr. Piping
Orifice Plate

Reducing

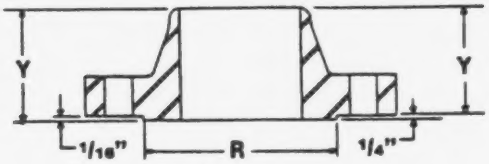


Long Neck

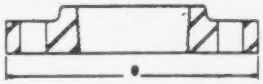


8. **Types of flange facings and their characteristics**

a. **Raised-face** — Machine tool finished with concentric grooves; generally used with soft flat ring gaskets

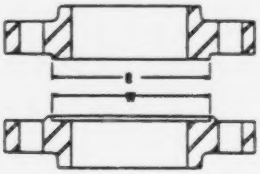


b. **Flat-face** — Used with 125# and 250# cast iron valves and fittings that permit using a flat gasket whose outer diameter equals that of the flange

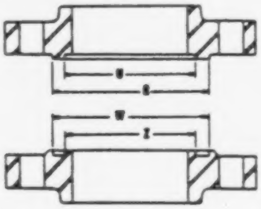


Information Sheet

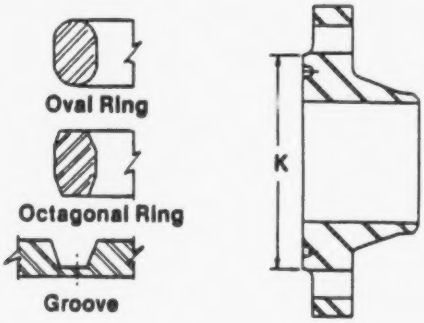
c. **Male and female face** — Used where the outer diameter of the female face acts to locate and retain the gasket



d. **Tongue and groove face** — The inner and outer groove diameters provide a minimum area for retaining and compressing the flat gasket, thus resulting in a minimum bolting load



e. **Ring joing face** — A flat bottom groove in a flange that uses an octagonal or oval cross-section shaped metal ring gasket and must match a similar flange facing



Information Sheet

9. **Types of gaskets with gasket materials**

   a. **Flat ring** — Made of paper, cloth, rubber, compressed asbestos, ingot iron, copper, aluminum, and other various combinations of materials

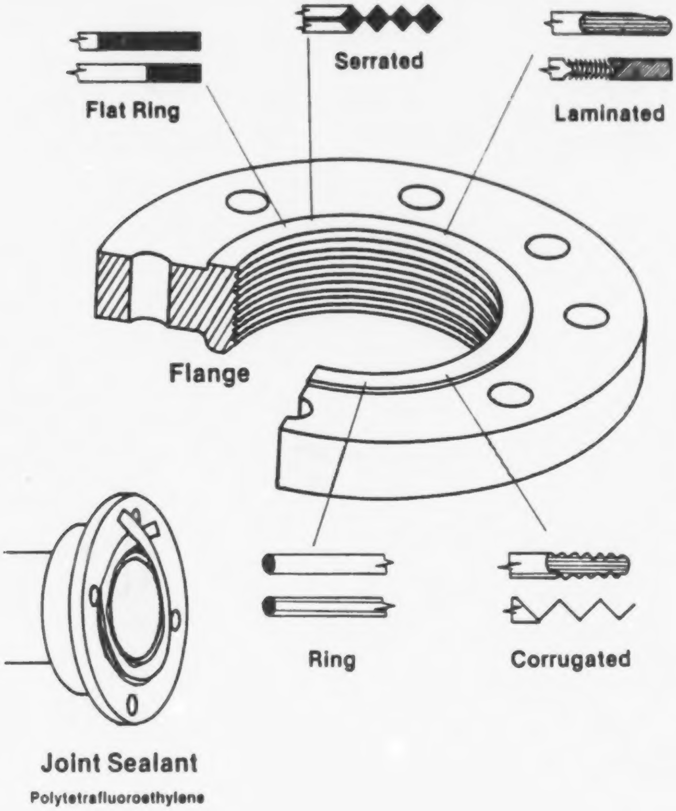
   b. **Serrated** — Concentric grooves machined into face of flat metal for use with smooth-finished flange face

   c. **Laminated** — Made of metal and soft filler material, are suitable for about 100 degree higher temperatures than plain asbestos gaskets

   d. **Corrugated** — Available plain or asbestos filled, are not commonly used

   e. **Ring joint** — Made of softest carbon metal and available in octagonal or oval cross-section shapes for use in high temperature and corrosive conditions

   f. **Joint sealant** — Made of low density Teflon in a cord from and used where conditions require a material with wide temperature range, no deterioration due to age, unaffected by chemicals, and no contamination to flow products



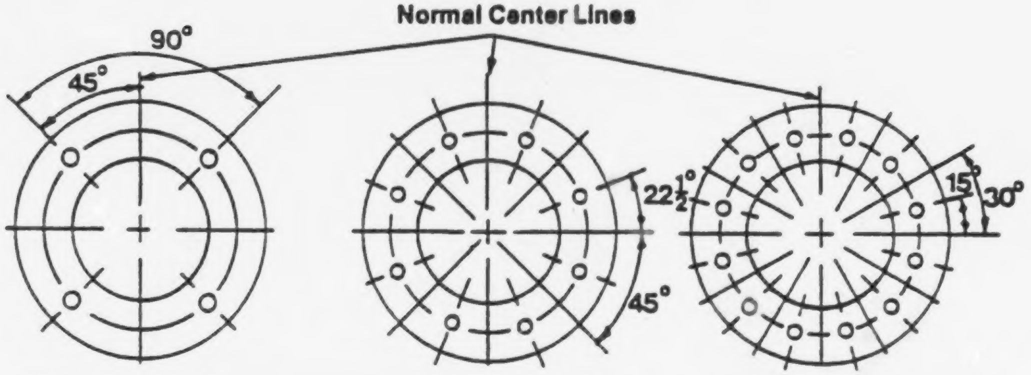
Information Sheet

10. Flange bolting standards

a. Bolt patterns come in equal groups.

Example: 4, 8, 12

b. Bolt holes are spaced equally between centerline.



Flange with 4 Holes

Flange with 8 Holes

Flange with 12 Holes

c. Generally speaking, the higher the pressure, the greater the number of flange bolts required, and the larger the flange, the greater number of flange bolts required.

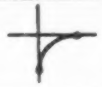
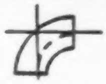
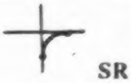
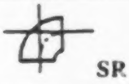
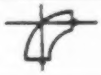
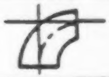
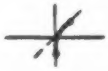
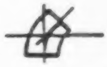
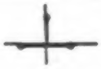
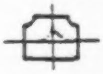
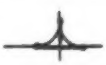
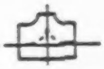
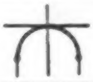
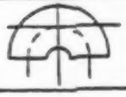
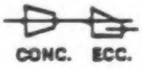
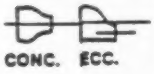
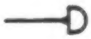
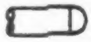
d. The number of flange bolt holes required is related to service conditions and other temperature and pressure standards set by ANSI.

Information Sheet

11. Welded fitting and flange symbols

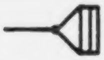
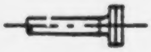
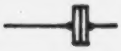
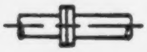
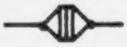
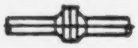
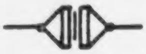
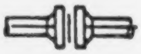
Note: Many of the symbols remain the same as when drawing flow diagrams, however on pipe drawings, all symbols are drawn to scale.

a. Fittings

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1. Elbow, 90° long radius		
2. Elbow, 90° short radius		
3. Elbow, reducing, 90° long radius		
4. Elbow, 45° long radius		
5. Tee, straight		
6. Tee, reducing outlet		
7. Return, 180°		
8. Reducers, concentric and eccentric		
9. Cap		

Information Sheet

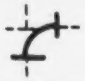
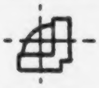
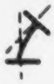
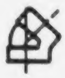
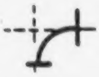
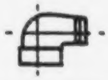
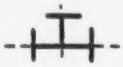
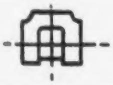
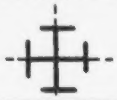
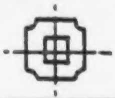
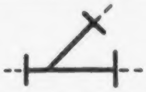
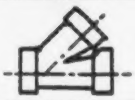
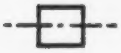
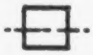
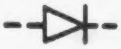
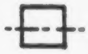
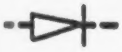
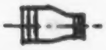
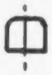
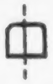
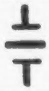
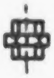
b. Flanges

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
1. **Blind**		
2. **Slip-on**		
3. **Weld neck**		
4. **Orifice**		

Information Sheet

12. Threaded fitting symbols

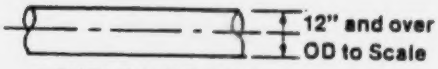
Note: These are also commonly referred to as screwed fittings.

	SINGLE LINE SYMBOLS	DOUBLE LINE SYMBOLS
A. Elbow, 90°		
B. Elbow, 45°		
C. Elbow, Street		
D. Tee		
E. Cross		
F. Y-Bend, 45°		
G. Coupling, Full		
H. Reducer		
I. Swaged Nipple		
J. Cap		
K. Union		

Information Sheet

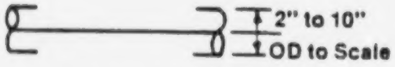
13. **Guidelines for drawing pipe**

    a. Draw pipe that is 12″ or larger with double lines.

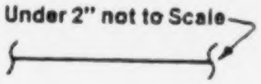

12" and over
OD to Scale

DOUBLE LINE PIPE

    b. Draw pipe ODs on pipe breaks to scale on pipe that is 2″ or larger, but pipe breaks on pipe less than 2″ do not have to be to scale.


2" to 10"
OD to Scale

SINGLE LINE PIPE


Under 2" not to Scale

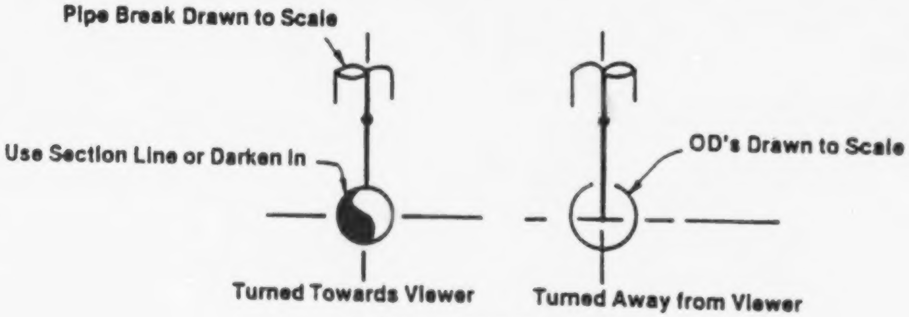
SINGLE LINE PIPE

    c. Check company standards to determine whether pipe should be drawn with single or double lines.

14. **Guidelines for drawing pipe components**

    a. Whether it's single line or double line pipe drafting, always construct the pipe size and welded fittings to scale.

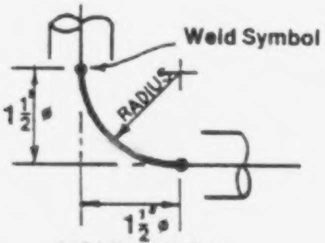
    b. In views turned toward or turned away from the viewer, construct nominal pipe size and welded fittings' OD to scale.


Pipe Break Drawn to Scale
Use Section Line or Darken In
OD's Drawn to Scale
Turned Towards Viewer
Turned Away from Viewer

SINGLE LINE 90° ELBOW

Information Sheet

c. Construct the radius of long radius elbows 1 1/2 times the nominal pipe size.

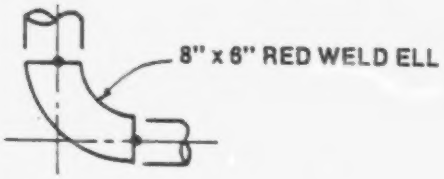

Weld Symbol
RADIUS
1½"ø
1½"ø

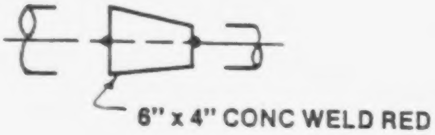
90° LR ELBOW

d. Construct the radius of short radius elbows equal to the nominal pipe size.

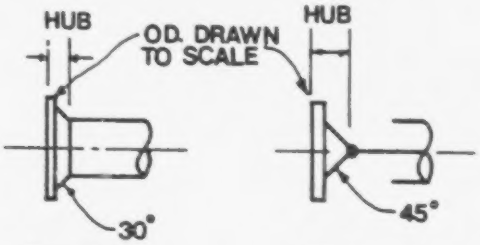
e. Construct the radius of 45° elbows 1 1/2 times the nomial pipe size.

f. Construct all reducing fittings with double lines.


8" x 6" RED WELD ELL


6" x 4" CONC WELD RED

g. Draw flange OD and the hub thickness of flanges to scale.


HUB
O.D. DRAWN TO SCALE
HUB
30°
45°

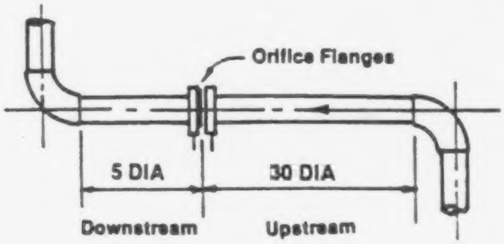
Double Line

Single Line

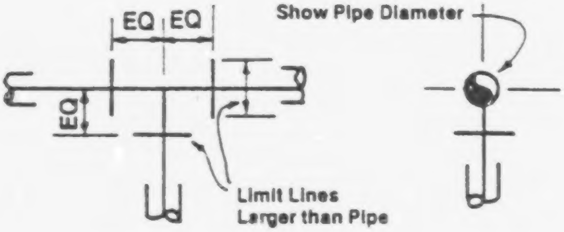
WELD NECK FLANGE

Information Sheet

h. In reference to the direction of flow in pipe from ells, tees, or branch connections, draw orifice flanges 30 diameters upstream and 5 diameters downstream.


Orifice Flanges
5 DIA
30 DIA
Downstream
Upstream

i. Draw screwed fitting limit lines to scale and slightly longer than the pipe diameter.


EQ
EQ
EQ
Show Pipe Diameter
Limit Lines
Larger than Pipe

FRONT VIEW

SIDE VIEW

Pipe and Pipe Components
Unit 3

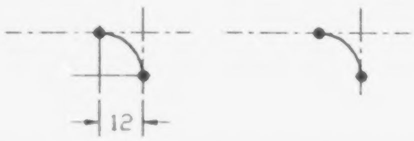
Assignment Sheet 1—Look Up Fitting Dimensions and Draw Symbols

Name ______________________ Overall Rating __________

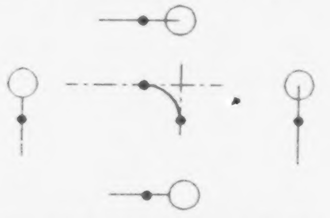
Evaluation criteria	**Rating**
Dimensions properly transferred	______
Single and double line orthographic symbols used	______
3/8" = 1'-0" scale used	______

Special background information: When constructing single line symbols, proportional size of screwed or socket fittings is more important than the actual to-scale size of symbols. As a convention in the industry, symbols are drawn larger, and most drafters use a welding fitting template as an aid in drawing single line symbols. On all double line drawings, the pipeline and fitting must include a centerline and two outer lines which represent the outside diameter of pipe. The orthographic method is used in drawing views of single line and double line symbols. Use reference materials for determining dimensions needed for drawing symbols. The following example shows how to look up fitting dimensions and how to draw symbols using templates.

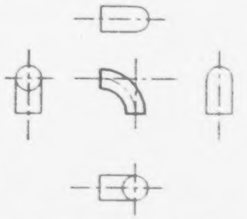
Example: From a reference for a 8" nominal pipe size standard weight 90° LR weld elbow, draw single and double line symbols for an 8" 90° LR WELD ELL. In the first step, box in the centerline to face dimension of 12". Draw a 3-point arc. PEDIT if desired (not necessary). Add donuts to represent butt weld symbols, and turn off construction layers.



Complete the drawing by adding side views in proper projection as required.



SINGLE LINE 90° WELD ELL



DOUBLE LINE 90° WELD ELL

Assignment Sheet 1

Directions: Look up the required dimensions for the following fittings, using reference materials such as a pipe fitter's pocket manual or pipe manufacturers' catalogs. Draw single and double line orthographic symbols using templates and the fitting chart that accompanies this assignment sheet. Produce drawings at a scale of 3/8″ - 1′-0″.

Problems:

A. 12″ 90° LR WELD ELL

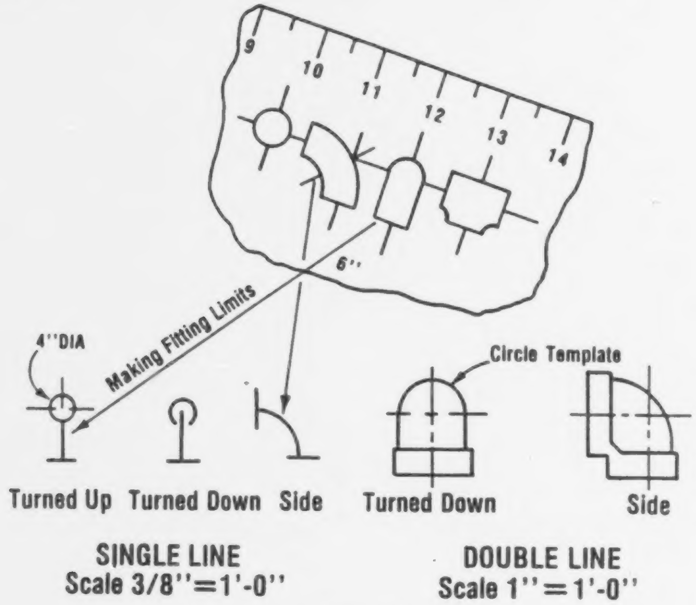
B. 8″ 90° SR WELD ELL

C. 8″ × 6″ STD WT weld

D. 4″ STD WT weld tee

Assignment Sheet 1

Note: Refer to the following figure to complete the threaded and socket weld fittings in the following problems.


9
10
11
12
13
14
6''
Making Fitting Limits
4''DIA
Circle Template
Turned Up
Turned Down
Side
Turned Down
Side
SINGLE LINE
Scale 3/8''=1'-0''
DOUBLE LINE
Scale 1''=1'-0''

4'' 2000# 90° ELL

E. 2″ 2,000# threaded 90° elbow

F. 3″ 6,000# threaded tee

G. 1″ 3,000# threaded coupling

Assignment Sheet 1

H. 3″ 2,000# socket weld 45°

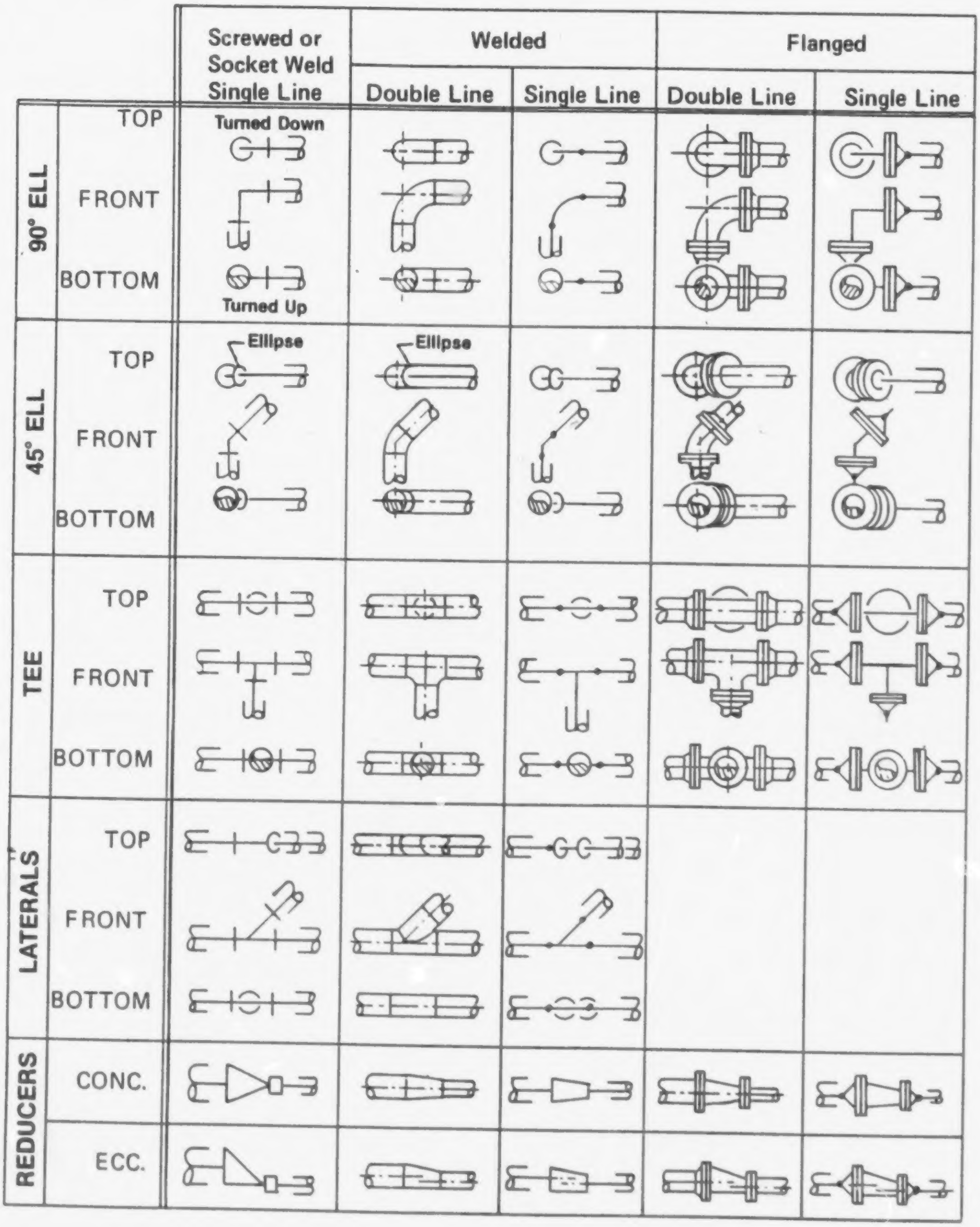
I. 10″ 600# weld neck flange

J. 6″ 300# weld neck flange

K. 8″ 150# WN FLG

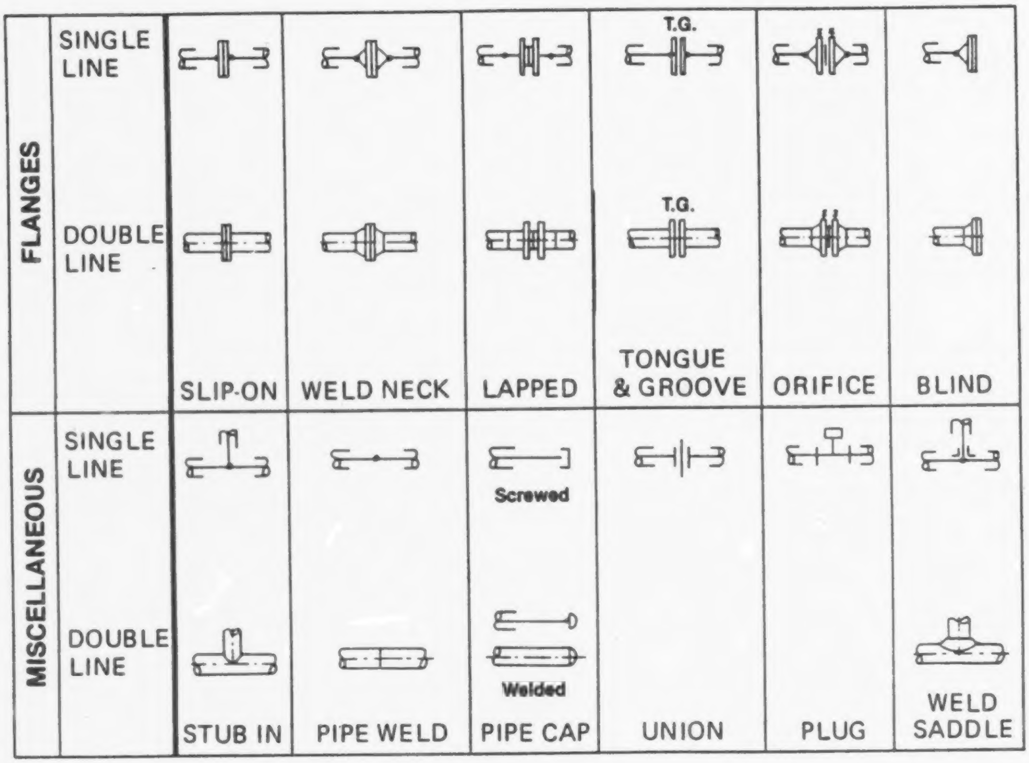
Assignment Sheet 1

Fitting Chart


Screwed or Socket Weld Single Line
Welded
Flanged
Double Line
Single Line
Double Line
Single Line
90° ELL
TOP
FRONT
BOTTOM
Turned Down
Turned Up
45° ELL
TOP
FRONT
BOTTOM
Ellipse
Ellipse
TEE
TOP
FRONT
BOTTOM
LATERALS
TOP
FRONT
BOTTOM
REDUCERS
CONC.
ECC.

Assignment Sheet 1

Fitting Chart (Continued)


FLANGES
SINGLE LINE
DOUBLE LINE
T.G.
T.G.
SLIP-ON
WELD NECK
LAPPED
TONGUE & GROOVE
ORIFICE
BLIND
MISCELLANEOUS
SINGLE LINE
DOUBLE LINE
Screwed
Welded
STUB IN
PIPE WELD
PIPE CAP
UNION
PLUG
WELD SADDLE

Pipe and Pipe Components
Unit 3

Assignment Sheet 2—Construct Single Line Drawings of Screwed and Socket Weld Pipe Fittings

Name ______________________________ Overall Rating __________

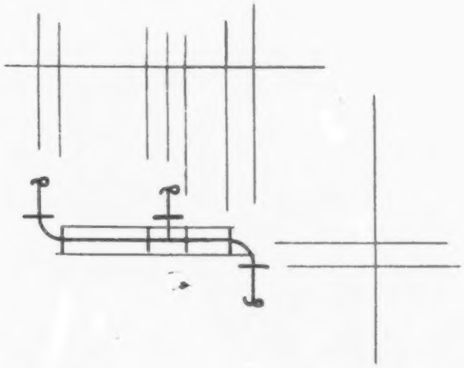
Evaluation criteria	Rating
Missing views properly drawn	_____
Fitting limit lines and pipe properly projected	_____
Angled fittings projected as ellipses	_____

Special background information: For pipe 2″ and smaller, screwed and socket weld fittings are drawn single line. Orthographic projection for pipe is exactly the same as that used in basic drafting in piping views, and are usually referred to as plan, elevation, and section views. In the following problems, construction lines have been shown so that the fitting limit lines and pipe can be projected. These lines are not normally shown on piping drawings, but are shown here to aid in adding the missing views. When single line piping has fittings running at an angle, project them as ellipses in the top and side views.

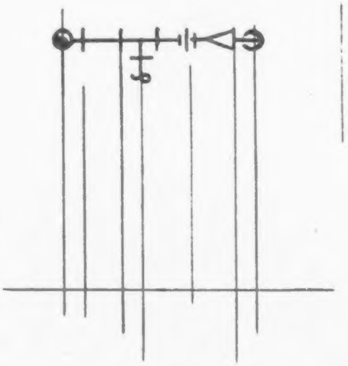
Directions: Construct the required missing views for the following problems. Consult the Fitting Chart in Assignment Sheet 1 to assist you.

Problems:

A.

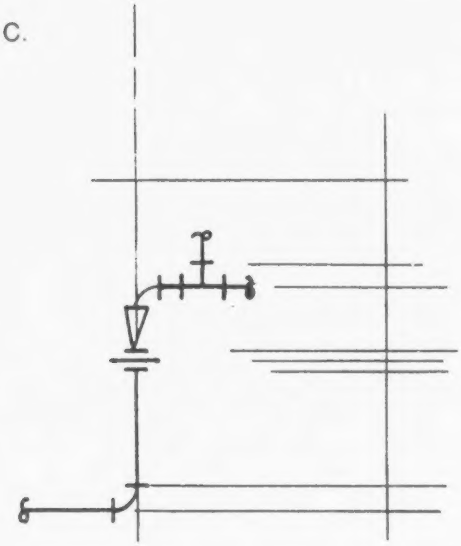


B.

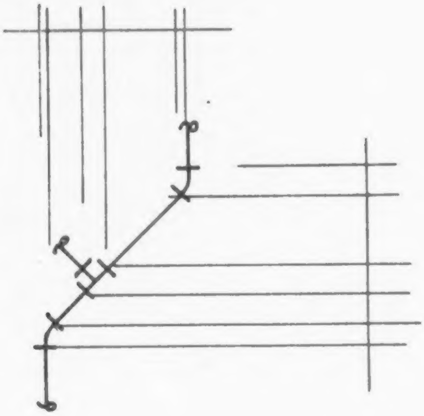


Assignment Sheet 2

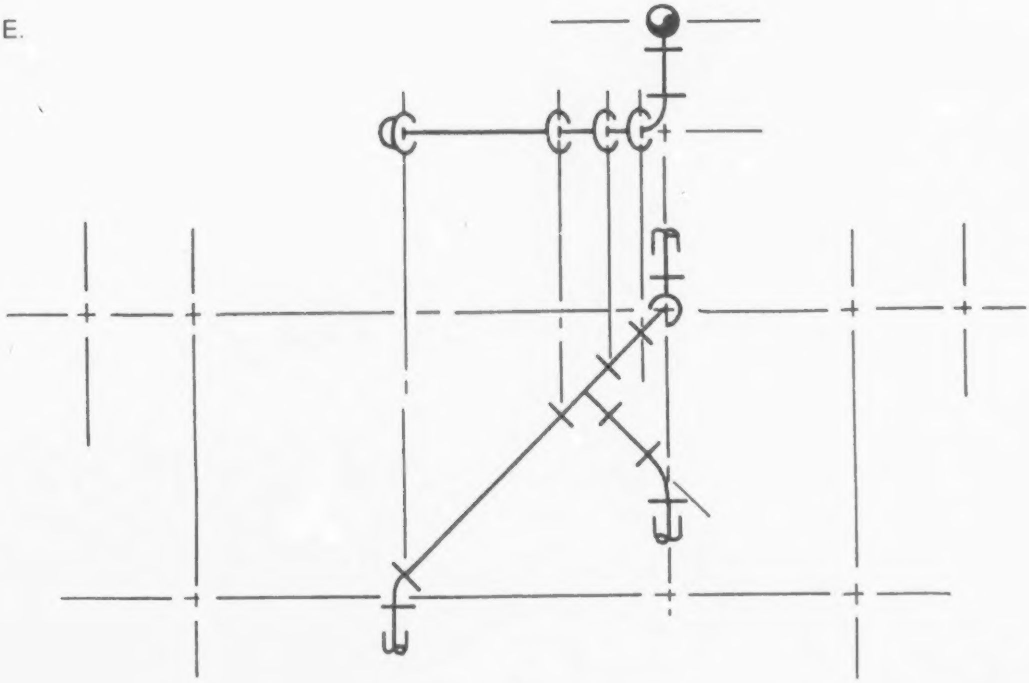
C.



D.



E.



Pipe and Pipe Components
Unit 3

Assignment Sheet 3—Construct Single Line Drawings of Welded Pipe Fittings

Name ________________________________ Overall Rating __________

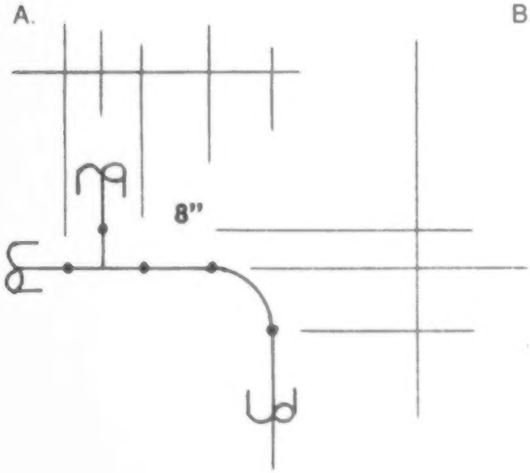
Evaluation criteria	**Rating**
Single line drawings properly completed	______
Proper scale used	______
Angled weld dots properly projected as ellipses	______

Special background information: Pipe sizes under 12″ are commonly drawn single line, and welds are shown as large dots. When single line piping has weld dots running at an angle to a view, they are projected as elipses. The point where the centerline of the weld intersects the centerline of the drawing becomes the centerline of the projected ellipse.

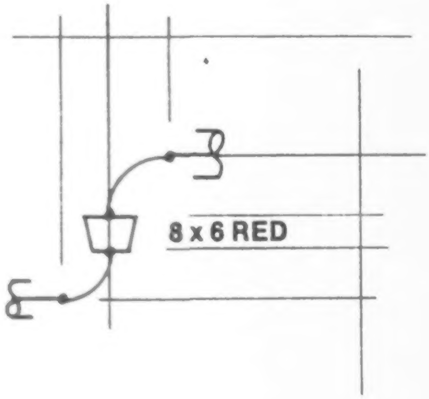
Directions: Reference the typical views shown in the Fitting Chart in Assignment Sheet 1, and construct the required missing views for the following problems. Use a scale of 3/8″ = 1′-0″.

Problems:

A.

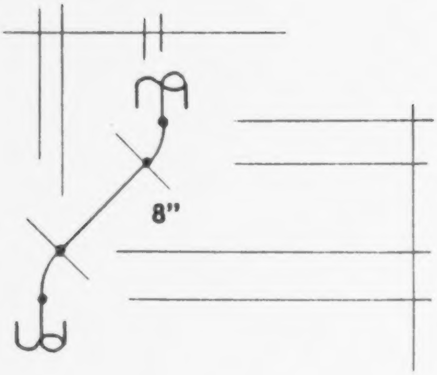


B.

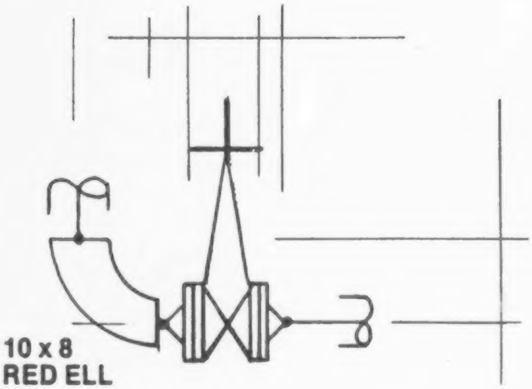


Assignment Sheet 3

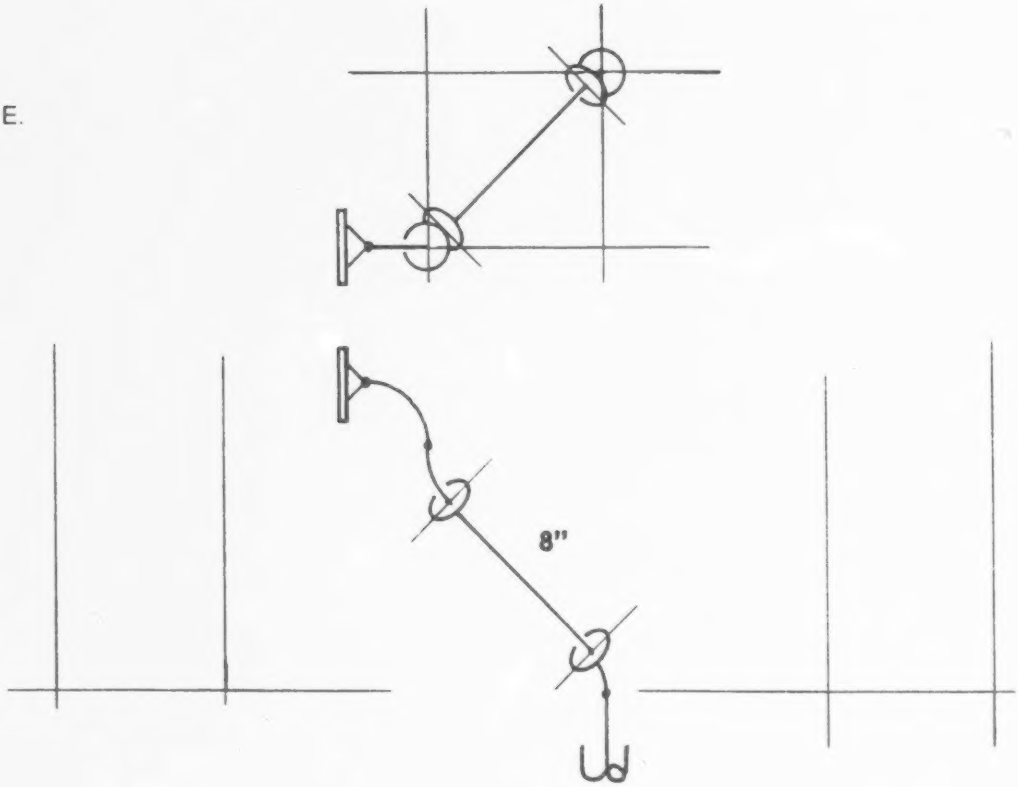
C.



D.


10 x 8
RED ELL

E.



Pipe and Pipe Components
Unit 3

Assignment Sheet 4—Construct Double Line Drawings of Welded Pipe Fittings

Name ______________________________ Overall Rating ________

Evaluation criteria	**Rating**
Double line drawings properly completed	______
14″ fitting selected	______
Proper scale used	______

Special background information: With single line drawings, it is conventional in industry to draw the symbols larger than really required in order to highlight proportion, but with double line drawings, the symbols are used to show exact relationships between lines and equipment.

Directions: Change the fitting sizes to 14″, but use the same problems in Assignment Sheet 3 to construct double line drawings on "A" size vellum using a scale of 3/8″ = 1′-0″. When pipe runs are required, use a minimum 12″ length of pipe.

Pipe and Pipe Components
Unit 3

Assignment Sheet 5—Complete Dimensions for Single Line Drawings of Butt Weld and Screwed Fittings

Name ______________________________ Overall Rating __________

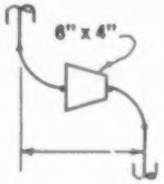
Evaluation criteria	**Rating**
Butt weld fitting dimensions complete	______
Screwed fitting dimensions complete	______
Gasket allowance noted	______

Special background information: In plans, elevations, and fabrication drawings, detailed dimensions of piping are required, and single line drawings are most frequently used.

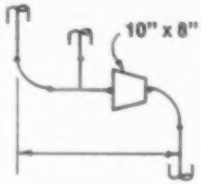
Directions: Refer to manufacturers' catalogs for fitting dimensions, allow for 1/8" gasket thickness between flanges, and then fill in the dimensions for the following butt weld and screwed single line drawings.

Problem A: Butt weld single line drawings

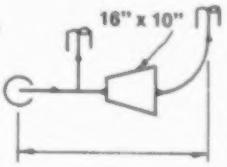
(1)



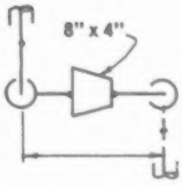
(2)



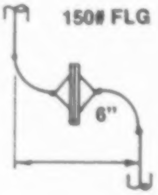
(3)



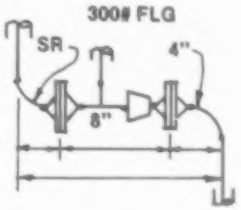
(4)



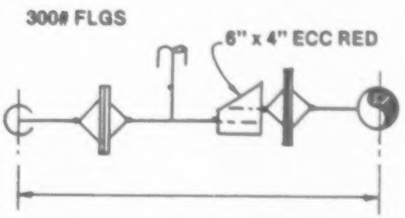
(5)



(6)



(7)

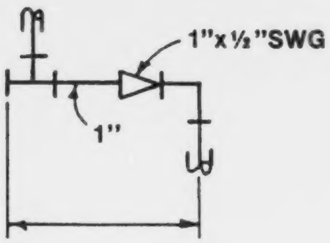


Assignment Sheet 5

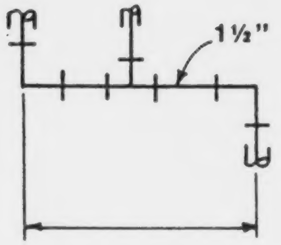
Problem B: Screwed fittings single line drawings

Note: Use a thread engagement chart as required, and assume all nipple connections are 6″.

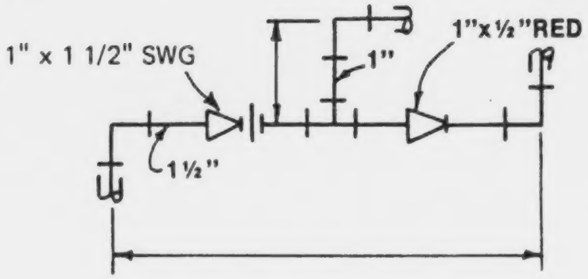
(1)



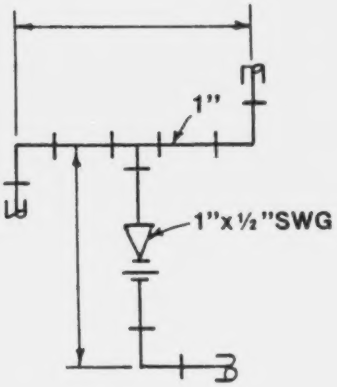
(2)

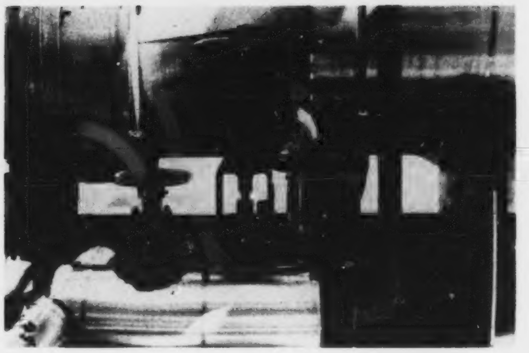


(3)


1" x 1 1/2" SWG
1"
1"x½"RED
1½"

(4)





Valves
Unit 4

Objective Sheet

Unit Objective

After completing this unit, the student should be able to determine data for check valves, gate valves, and stainless steel valves. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to valves with their correct definitions.
2. List primary functions of valves.
3. Identify basic parts of a valve.
4. Complete statements about gate valves and their characteristics.
5. Complete statements about globe valves and their characteristics.
6. Match types of check valves with their characteristics.
7. Complete statements about angle valves and their characteristics.
8. Complete statements about needle valves and their characteristics.
9. Complete statements about Y-pattern valves and their characteristics.
10. Select true statements about butterfly valves and their characteristics.

Objective Sheet

11. Complete statements about safety and relief valves and their characteristics.
12. Complete statements about diaphragm valves and their characteristics.
13. Select true statements about ball valves and their characteristics.
14. Complete statements about plug valves and their characteristics.
15. Select true statements about applications of steel and steel alloys.
16. Match valve body materials with their characteristics.
17. Match types of bonnet assemblies with their applications.
18. Match inlet/outlet connections with their applications.
19. Match types of stems with their characteristics.
20. Select true statements about types of valve actuators.
21. Solve a problem about factors to consider when selecting a valve actuator.
22. Identify valve symbols.
23. Complete a list of abbreviations for describing valve body materials.
24. Complete a list of abbreviations for valve pressure ratings.
25. Complete a list of abbreviations for operating mechanisms.
26. Complete a list of abbreviations for facings, disks, and joints.
27. Complete a list of abbreviations for end joints.
28. Determine data for check valves. (Assignment Sheet 1)
29. Determine data for gate valves. (Assignment Sheet 2)
30. Determine data for stainless steel valves. (Assignment Sheet 3)

Valves
Unit 4

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan for enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from the transparency masters included with this unit. These appear in the teacher guide only and are designed to be used with the following objectives:

   TM 1—Functions of Valves (Objective 2)
   TM 2—Functions of Valves (Continued) (Objective 2)
   TM 3—Basic Parts of a Valve (Objective 3)
   TM 4—Parts of a Control Valve (Objective 3)
   TM 5—Types of Valves (Objective 4)
   TM 6—Types of Valves (Objective 4)
   TM 7—Types of Valves (Objective 4)
   TM 8—Typical Bolted Bonnet Gate Valve (Objective 4)
   TM 9—Typical Globe Valve (Objective 5)
   TM 10—Typical Swing Check Valve (Objective 6)
   TM 11—Tilting Disc Check Valve (Objective 6)
   TM 12—Typical Stop Check Valve (Objective 6)
   TM 13—Monarch Butterfly Valve (Objective 10)
   TM 14—Bonnet Assemblies (Objective 17)
   TM 15—Type of Stems (Objective 19)
   TM 16—Methods of Valve Operation (Objective 20)
   TM 17—Electromechanical Actuator (Objective 20)
   TM 18—Handwheels (Objective 20)

5. Develop teaching plan. Adjust for different learning styles.

6. Make copies of Unit Evaluation Form.

Suggested Activities

Delivery and Application

7. Provide students with unit of instruction.

8. Discuss unit and specific objectives.

9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.

10. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignments.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Have samples of as many different types of valves as you can gather from local industries or area petroleum production facilities. Stress the significance of each valve design with respect to its applications. Discuss the design importance of knowing what kind of service a valve will be subjected to. Discuss critical and noncritical service. Skill areas: **Learning skills, learning to learn.**

2. Use the graphics in Student Supplement 1 to better advantage by making them a part of the discussions of the different types of valves presented in Objective 4 through 14. This is a good way to expose students to the references they will need to use to complete all of the assignment sheets. Skill areas: **Learning skills, learning to learn.**

Suggested Activities

3. Have students read and go over Student Supplement 2 in groups of two or three. Assign each group a certain part of the valve to discuss with the rest of the class. Skill areas: **Group effectiveness skills, teamwork.**

Resources Used in Developing This Unit

1. *ANSI/ASME Y32.2.3-1949 (R1988), Graphical Symbols for Pipe Fittings, Valves, and Piping.* New York: American National Standards Institute, 1988.
2. *CADalyst.* Bellingham, WA: Cadalyst Publications, Ltd., 1992.
3. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-American Vocational Curriculum Consortium, 1983.
4. *Engineering Data.* Chicago: The Crane Company, 1992.
5. *Publication AC11RM, AutoCAD Reference Manual.* New York: Autodesk Inc., 1990.
6. *Types 7 SA and 7 SAR Electromechanical Actuators.* Marshalltown, IA: Fisher Controls International, 1980.
7. *Type 1066 and 1066 SR On-Off Piston Rotary Actuators.* Marshalltown, IA: Fisher Controls International, 1984.

Suggested Supplemental Resources

1. Weaver, Rip. Video Tape Series: Process Pipe Drafting, Piping Familiarization, Piping Pointers, and Blueprint Reading Basics. Gulf Publishing Company, Book Division, P.O. Box 2608, Houston, TX 77252-2608.
2. Cadpipe Ortho, Iso, P&ID Forms, Software Package, Digitizer Driven. Endeco Engineering Ltd., 200 Carnegie Drive, St. Albert, Alberta T8N 5A7 CANADA, (403) 459-9041.
3. Pro-Pipe, Software Package, Isometric pipe drafting package. Industrial Graphics, P.O. Box 509, Branch, MI 49402, (616) 898-2701.
4. Piping Schematic Symbols Library. Drafting Technology Services, 2425 Nowata Place, Suite 202, Bartlesville, OK 74006, (918) 335-2480.

Valves
Unit 4

Answers to Assignment Sheets

Assignment Sheet 1

1. a. 17.5
   b. 21
   c. 14
   d. 38.5

2. a. 33
   b. 255
   c. 570
   d. 2,425

3. a. 14
   b. 54
   c. 30
   d. 33

4. a. 690
   b. 57
   c. 10,000
   d. 240

5. a. 4
   b. 21.50
   c. 3.50
   d. 26

Assignment Sheet 2

1. a. 3.94
   b. 5.32
   c. 6.50
   d. 7.28

2. a. 5.75
   b. 6.50
   c. 9.19
   d. 10.38

Answers to Assignment Sheets

3. a. 11.5
   b. 24
   c. 12
   d. 18

4. a. 1,120
   b. 6,860
   c. 730
   d. 1,250

5. a. 31
   b. 55
   c. 89
   d. 143.50

Assignment Sheet 3

1. a. 11 1/2
   b. 27 1/2
   c. 16
   d. 6 1/2
   e. 4 1/2
   f. 6 1/2
   g. 13
   h. 8

2. a. 42
   b. 27 1/2
   c. 21 3/8
   d. 12
   e. 8 3/8
   f. 12
   g. 49 7/8
   h. 17 3/8

3. a. 276
   b. 435
   c. 173
   d. 23
   e. 7
   f. 23
   g. 454
   h. 50

4. a. 8
   b. 14 7/8
   c. 3
   d. 4 1/2

Valves
Unit 4

Answers to Written Test

1.	a.	6	e.	2	i.	1
	b.	7	f.	8	j.	4
	c.	5	g.	3	k.	10
	d.	11	h.	9	l.	12

2. The following may appear in any order:

   a. Start and stop flow
   b. Regulate or throttle flow
   c. Prevent backflow
   d. Relieve pressure
   e. Regulate pressure

3. a. Packing
   b. Stem
   c. Bonnet
   d. Disc
   e. Body

4. a. Stop
   b. Fully open or fully closed
   c. Minimum
   d. Are not

5. a. Throttling service
   b. Close throttling

6. a. 2
   b. 3
   c. 1

7. a. Globe, globe
   b. Critical

8. a. High, high
   b. Flow

9. a. Quick
   b. Less

10. b

Answers to Written Test

11. a. Liquid
    b. Liquid

12. a. Throttling
    b. High

13. a, b

14. a. On/off
    b. Slurry

15. a, b

16. a. 3
    b. 1
    c. 4
    d. 2

17. a. 3
    b. 1
    c. 2

18. a. 4
    b. 2
    c. 1
    d. 3

19. a. 3
    b. 1
    c. 4
    d. 2

20. a. Mechanically
    b. Gear-operated
    c. Mechanical
    d. Vacuum

21. a, b, c, d, f, g, h

Answers to Written Test

22. a. Welded globe
    b. Threaded check
    c. Welded gate
    d. Flanged ball
    e. Threaded angle
    f. Welded butterfly
    g. Threaded needle
    h. Flanged check
    i. Welded plug
    j. Welded control
    k. Flanged gate
    l. Flanged plug

23. a. Al
    b. AL
    c. BR
    d. CI
    e. Cr
    f. CS
    g. DI
    h. FS
    i. IBBM
    j. MI
    k. Mo
    l. N
    m. PVC
    n. SS
    o. Tef

24. a. CWP
    b. SP
    c. WOG
    d. WP
    e. WSP

25. a. NRS
    b. OS&Y
    c. RS

26. a. DD
    b. FF
    c. RF
    d. RTJ

Answers to Written Test

27. a. BW
    b. FE
    c. FFD
    d. SE
    e. SJ
    f. SW

Valves
Unit 4

Written Test

Name ______________________________ Date ____________ Score ________

1. Match the terms on the right with their correct definitions.

______a. A substance composed of two or more metals to produce a desired quality of metal, used to make valve components

______b. A device that will operate a valve, either opening or closing by remote control

______c. Part of a valve which covers the internal moving parts, contains a means of sealing the stem against leakage, and provides a means for attaching an actuator

______d. Valves that operate under high pressure, high temperature, and fire or other hazardous situations

______e. Valve component which initiates, shuts off, or regulates flow

______f. Cast iron which has been heat treated to relieve brittleness and improve tensile strength

______g. Valves that operate under low pressure to moderate pressure situations

______h. Valve inlet and outlet openings

______i. Valve component which moves the disk on and off the valve seat, can be manually, pressure, or actuator controlled

1. Stem
2. Disc
3. Noncritical service
4. Thermal shock
5. Bonnet
6. Alloy
7. Actuator
8. Malleable iron
9. Ports
10. Throttling
11. Critical service
12. Trim

Written Text

______j. Valve stress caused by sudden rise or drop in temperature of the fluid in contact with the valve

______k. Controlled restriction of flow rate to maintain temperature or pressure

______l. Internal valve components such as seat rings, discs, stems, etc. which can be replaced during maintenance

2. List five primary functions of valves. The list of functions may be arranged in any order.

   a. ______________________________

   b. ______________________________

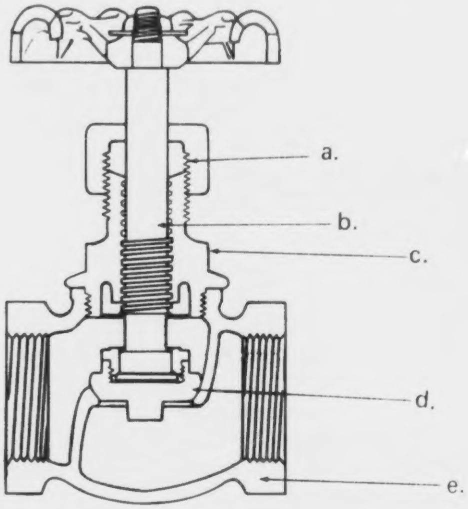
   c. ______________________________

   d. ______________________________

   e. ______________________________

Written Test

3. Identify the basic parts of a valve. Insert the name of the valve part in the appropriate blank below the following illustration.



a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________

4. Complete statements about gate valves and their characteristics. Circle the material that best completes each of the following statements.

   a. Gate valves are efficient (**stop**) (**control**) valves because flow can move in either direction.

   b. Gate valves function best when (**fully open or fully closed**) (**quarter open or quarter closed**).

   c. When they are fully open, gate valves offer little resistance to flow, and are commonly used in applications where (**minimum**) (**high**) pressure drop is important.

   d. Gate valves (**are**) (**are not**) recommended for throttling service.

Written Test

5. Complete statements about glove valves and their characteristics. Circle the material that best completes each of the following statements.

   a. Because globe valves have characteristics that permit accurate and repeatable flow control, they are ideal for (**low pressure applications**) (**throttling service**).

   b. Globe valves can be subject to excessive noise, vibration, and even damage when applications call for extremely (**close throttling**) (**high temperatures**).

6. Match types of check valves with their characteristics. Place the number of the valve in the blank beside the description of its characteristics.

   ______a. These types of check valves can be readily installed in both horizontal and vertical flow applications because they offer low resistance to flow and are well suited to low-velocity service.

   ______b. These types of check valves have a design modification that tilts the shut-off disc to reduce noise and vibration caused by the slamming effect when flow is reversed.

   ______c. These types of check valves have no mechanical connection between the stem and the disc; they are used in steam boiler outlet piping when two or more boilers are connected to a common header to prevent steam backflow from the header to the boiler.

   1. Stop check valves
   2. Swing check and lift check valves
   3. Tilting disc check valves

7. Complete statements about angle valves and their characteristics. Circle the material that best completes each of the following statements.

   a. Except for the fact that line fluid takes a 90° turn, angle valves have a design similar to (**globe**) (**check**) valves and are used for the same applications as (**globe**) (**check**) valves.

   b. The angle valve eliminates the need for a globe valve plus a 90° elbow, but they should not be used in (**medical**) (**critical**) service applications.

Written Test

8. Complete statements about needle valves and their characteristics. Circle the material that best completes each of the following statements.

   a. Needle valves are small and compact and can be used for small quantity measurement of (**low**) (**high**) temperatures and (**low**) (**high**) pressures.

   b. Needle valves are used for throttling and for exact (**flow**) (**heat**) regulation.

9. Complete statements about Y-pattern valves and their characteristics. Circle the material that best completes each of the following statements.

   a. Y-pattern valves have (**quick**) (**slow**) operating characteristics and that is why they are used primarily for throttling.

   b. The Y-pattern design offers (**slightly more**) (**less**) resistance to fluid flow, and affords less of a pressure drop than standard globe valves.

10. Select true statements about butterfly valves and their characteristics. Place an "X" beside each true statement.

    _______a. Butterfly valves are popular for on/off throttling applications because they are heavy and stand up well under severe service.

    _______b. The valve liner material in butterfly valves will not permit their use in extreme temperature applications.

11. Complete statements about safety and relief valves and their characteristics. Circle the material that best completes each of the following statements.

    a. Safety valves, sometimes called "pop-off" valves, are used strictly to relieve pressure in steam, air, or gas lines, but they are never used on (**slurry**) (**liquid**) lines.

    b. Relief valves are also called "pop-off" valves, but they are designed for use on (**slurry**) (**liquid**) lines, and their design usually diverts relieved liquid into another line or holding tank.

Written Test

12. Complete statements about diaphragm valves and their characteristics. Circle the material that best completes each of the following statements.

    a. As the word "diaphragm" indicates, diaphragm valves have a flexible disc that can be used to turn off/turn on flow, or used for (**critical applications**) (**throttling**).

    b. The design provides a leakproof closure affording little chance for contaminating the line substance, but the flexible disc should not be used in (**low**) (**high**) temperature applications.

13. Select true statements about ball valves and their characteristics. Place an "X" beside each true statement.

    ______a. Ball valves have a design that permits quick, quarter-turn operation.

    ______b. Ball valves have smooth flow characteristics because the design is non-sticking, self-sealing, and compact.

    ______c. Ball valves are somewhat limited because they are available in only one port design.

14. Complete statements about plug valves and their characteristics. Circle the material that best completes each of the following statements.

    a. Sometimes referred to as "cock" valves, plug valves are used for quick (**on/off**) (**throttling**) applications.

    b. The quick, quarter-turn action of a plug valve seals better than a gate valve, and is ideal for (**slurry**) (**liquid**) material because fluids cannot enter the valve body cavity.

15. Select true statements about applications of steel and steel alloys. Place an "X" beside each true statement.

    ______a. Steel and steel alloys are used for high temperature and high pressure applications that are too severe to cast iron, bronze, or brass.

    ______b. Steel and steel alloys are superior to cast iron, bronze, and brass because of their toughness and ability to resist strain, vibration, shock, low temperature, and fire damage.

    ______c. Steel and steel alloys are forged for larger sizes and cast for smaller sizes.

Written Test

16. Match valve body materials with their characteristics. Place the number beside the material in the blank beside the appropriate description.

______a. A copper and zinc alloy that is used for noncritical service at temperatures below 400°F and low pressures

______b. A copper and tin alloy that is used for temperatures up to 500°F and pressure up to 300 psi

______c. Available in three grades as cast iron, ferrosteel, or high-tensile iron for temperatures up to 450°F

______d. Used for piping materials subject to expansion and contraction, and stresses and shock because it exhibits characteristics of tightness, stiffness, and toughness

1. Bronze
2. Malleable iron
3. Brass
4. Iron

17. Match types of bonnet assemblies with their applications. Place the number beside the bonnet assembly type in the blank beside the appropriate description.

______a. Normally used on smaller valves in non-critical service; this is the least expensive of all bonnet designs and not recommended for frequent dismantling

______b. Recommended for critical service; come in larger sizes and are easily dismantled

______c. Normally used on smaller valves in critical service; no problems with dismantling under normal operating conditions

1. Bolted bonnets
2. Screwed untion bonnets
3. Screwed bonnets

Written Test

18. Match inlet/outlet connections with their applications. Place the number beside the connection type in the blank beside the appropriate description.

_______a. For critical service for applications which require infrequent dismantling

_______b. For critical service for applications which do require frequent dismantling

_______c. For smaller pipes in ordinary pressure applications; easily fitted into original equipment installations.

_______d. For nonflammable applications on copper or red brass piping

1. Screwed or threaded ends
2. Flanged ends
3. Soldered and socket-brazed ends
4. Welded ends

19. Match types of stems with their characteristics. Place the number beside the stem in the blank beside the description of the appropriate characteristics.

_______a. Requires adequate headroom; stem position indicates disc position

_______b. Requires less headroom; stem position does not indicate disc position

_______c. Used primarily for smaller valves; threads that control disc location are inside the bonnet and the stem threads are subject to thermal shock

_______d. Threads that control disc location are outside the bonnet, and position indicates disc position; stem threads are not subject to thermal shock

1. Nonrising stem
2. Outside screw
3. Rising stem
4. Inside screw

20. Complete statements about types of valve actuators. Circle the material that best completes each of the following statements.

a. Valves can be opened and closed manually or (**electronically**) (**mechanically**) with valve actuators.

b. Manual actuators include handwheels for smaller valves and (**hydraulically-operated**) (**gear-operated**) actuators for larger valves.

Written Test

c. (**Mechanical**) (**Manual**) actuators can be controlled with diaphragms, gears, or cylinders.

d. Mechanical actuators are often driven by a motor, and the motor signal may be transferred with air pressure or (**water pressure**) (**vacuum**), an electrical signal, or fluid pressure.

21. Select true statements about factors to consider in actuator selection. Place an "X" beside each statement that is true.

_______ a. Know the size and type of valve.

_______ b. Know the required opening and closing times.

_______ c. Know the valve operating pressure.

_______ d. Determine if the actuator environment is affected by a corrosive atmosphere, high temperature, or excessive moisture.

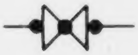
_______ e. Determine if the operation is part time or full time.

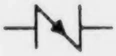
_______ f. Determine what motive force will operate the actuator: electric, pneumatic, or hydraulic force.

_______ g. Gather electric actuator information to include: operating and control voltage and phases available, type of motor and whether it is explosion proof or totally enclosed, and other features such as position indicators, position lights, push button station, or an integral starter package.

_______ h. Gather pneumatic actuator information to include: air supply pressure, pilot operation requirements, filter and lubricator types, solenoid valves, and limit switch operation.

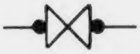
22. Identify the following valve symbols. Include the valve name and state whether the valve is threaded, welded, or flanged.



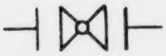


a. ______________________________ b. ______________________________

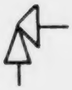
Written Test



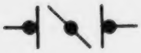
c. ____________________



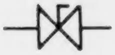
d. ____________________



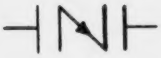
e. ____________________



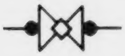
f. ____________________



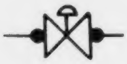
g. ____________________



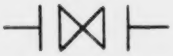
h. ____________________



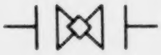
i. ____________________



j. ____________________



k. ____________________



l. ____________________

23. Complete the following list of abbreviations for describing valve body materials. Place the correct abbreviation in the blank beside the description.

a. ______ — All iron

b. ______ — Aluminum

c. ______ — Bronze

d. ______ — Cast iron

Written Test

e. ______ — Chromium

f. ______ — Cast steel

g. ______ — Ductile iron

h. ______ — Forged steel

i. ______ — Iron body bronze mounted

j. ______ — Malleable iron

k. ______ — Molybdenum

l. ______ — Nickel

m. ______ — Polyvinyl chloride

n. ______ — Stainless steel

o. ______ — Teflon

24. Complete the following list of abbreviations for valve pressure ratings. Place the correct abbreviation in the blank beside the rating.

a. ______ — Cold working pressure

b. ______ — Steam pressure

c. ______ — Water, oil, gas pressure

d. ______ — Working pressure

e. ______ — Working steam pressure

25. Complete the following list of abbreviations for operating mechanisms. Place the correct abbreviation in the blank beside the mechanism.

a. ______ — Nonrising stem

b. ______ — Outside screw and yoke

c. ______ — Rising stem

Written Test

26. Complete the following list of abbreviations for facings, disks, and joints. Place the correct abbreviation in the appropriate blank.

    a. ______ — Double disk

    b. ______ — Flat face

    c. ______ — Raised face

    d. ______ — Ring-type joint

27. Complete the following list of abbreviations for end connections. Place the correct abbreviation in the blank beside the connection type.

    a. ______ — Butt welded ends

    b. ______ — Flanged ends

    c. ______ — Flanged, faced, and drilled ends

    d. ______ — Screwed ends

    e. ______ — Soldered ends

    f. ______ — Socket welded ends

***Permission to duplicate this test is granted.**

Valves
Unit 4

Unit Evaluation Form

Student Name ______________________________ Unit Rating __________

Assignment Sheet 1—Determine Check Valve Data Rating ______

Comments: ____

____

Assignment Sheet 2—Determine Gate Valve Data Rating ______

Comments: ____

____

Assignment Sheet 3—Determine Stainless Steel Valve Data Rating ______

Comments: ____

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ____

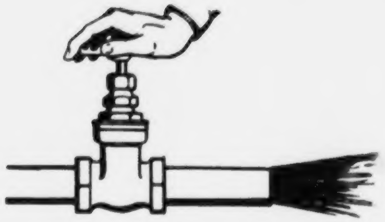
____

Teacher Signature ______________________________ Date __________

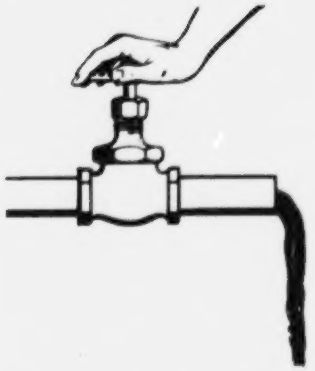
Student Signature ______________________________ Date __________

***Permission to duplicate this form is granted.**

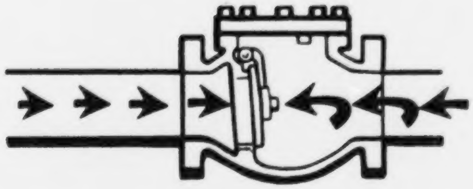
Functions of Valves



Start and Stop Flow
(Example: Gate Valve)

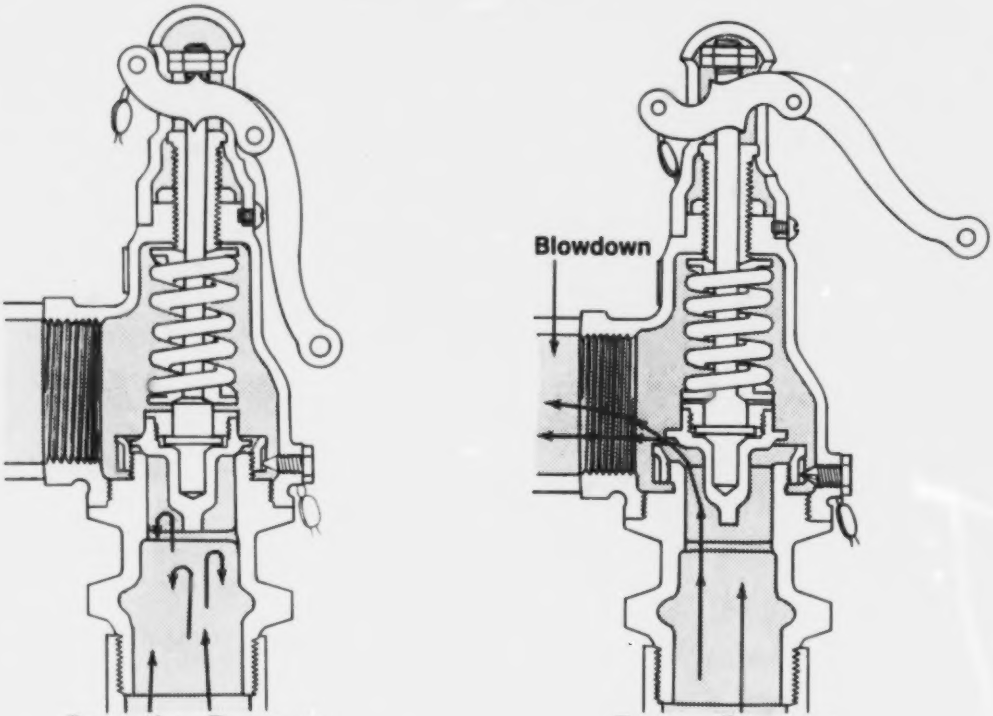


Regulate Flow
(Example: Globe Valve)



Prevent Back Flow
(Example: Check Valve)

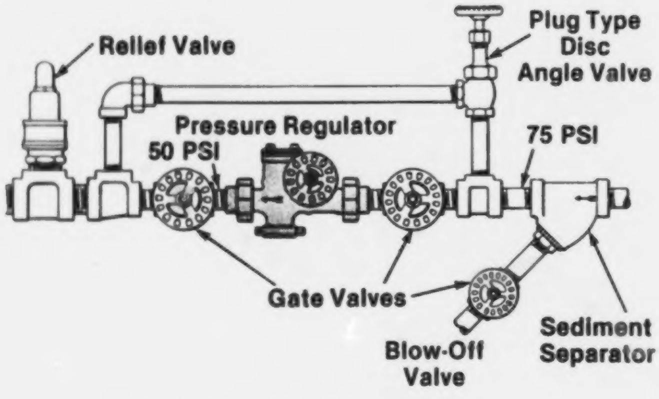
Functions of Valves
(Continued)



Operating Pressure

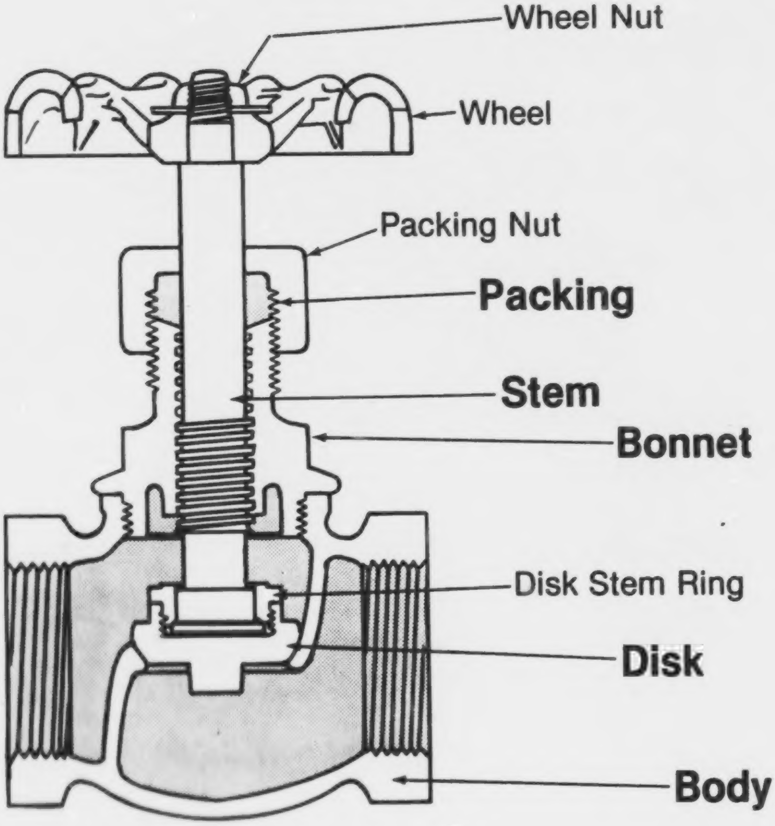
Excess Pressure

Relieve Pressure


Relief Valve
Plug Type Disc Angle Valve
Pressure Regulator
50 PSI
75 PSI
Gate Valves
Blow-Off Valve
Sediment Separator

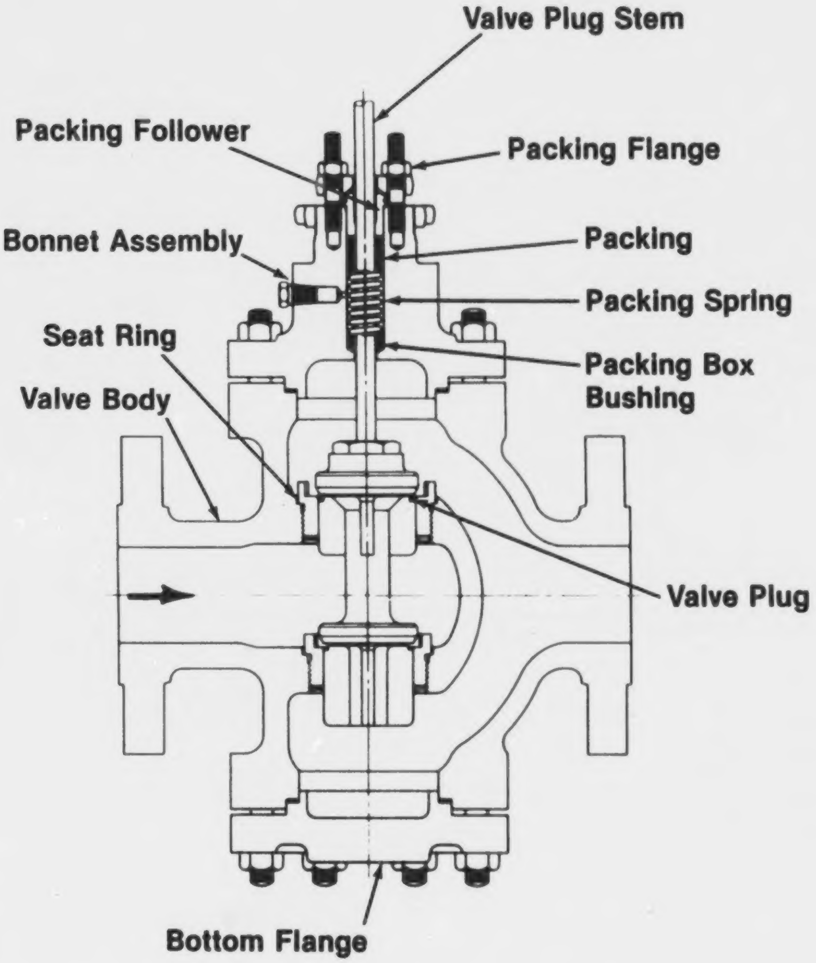
Regulate Pressure

Basic Parts of a Valve


Wheel Nut
Wheel
Packing Nut
Packing
Stem
Bonnet
Disk Stem Ring
Disk
Body

Globe Valve With Screwed Bonnet

Parts of a Control Valve

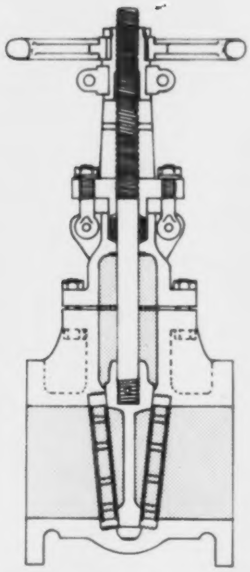


Valve Plug Stem
Packing Follower
Packing Flange
Bonnet Assembly
Packing
Packing Spring
Seat Ring
Packing Box Bushing
Valve Body
Valve Plug
Bottom Flange

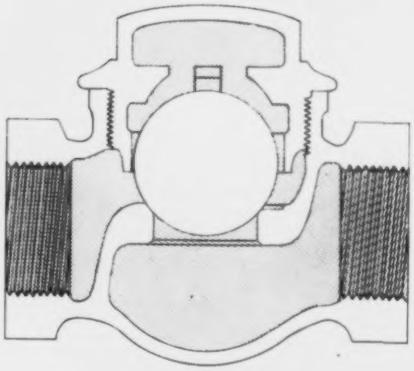
Direct Acting

Courtesy Fisher Controls Company

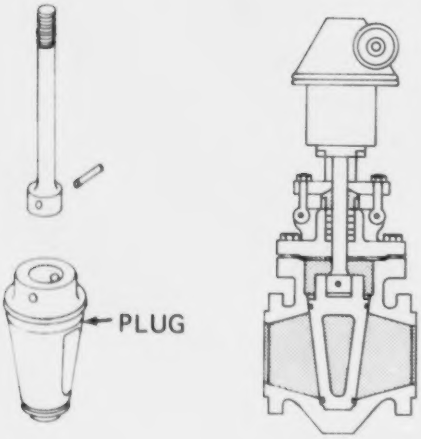
Types of Valves



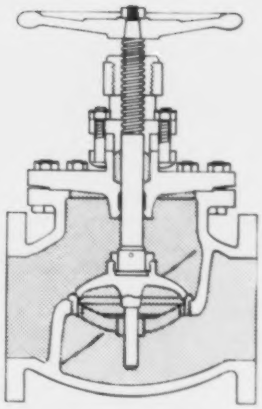
Gate Valve



Ball Valve

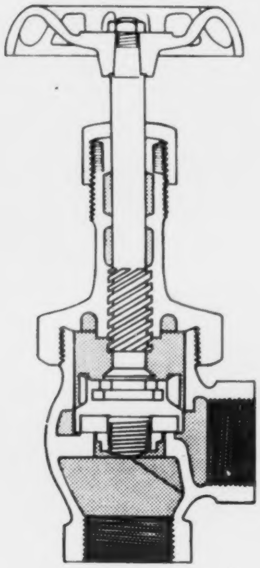


Plug Valve

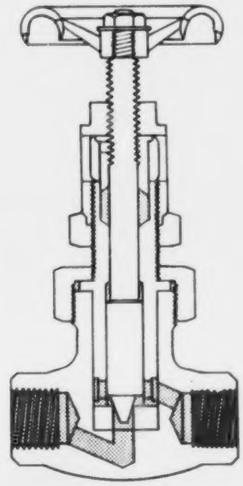


Globe Valve

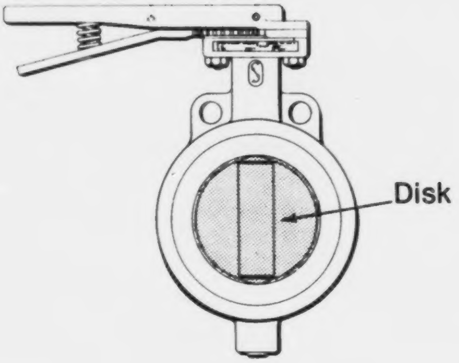
Types of Valves
(Continued)



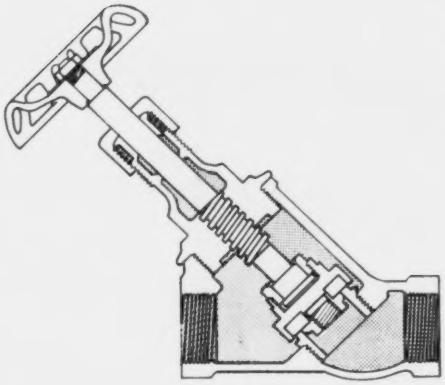
Angle Valve



Needle Valve

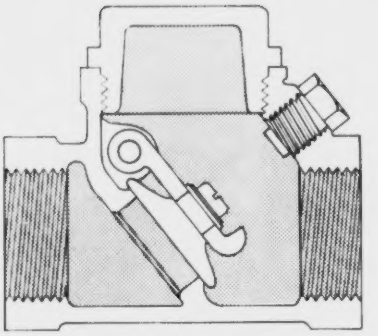


Butterfly Valve

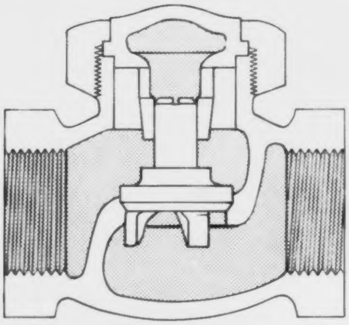


Y-Pattern Valve

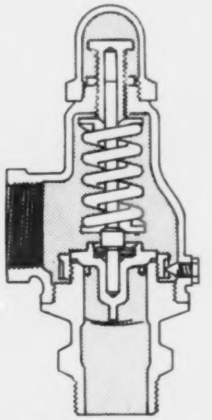
Types of Valves
(Continued)



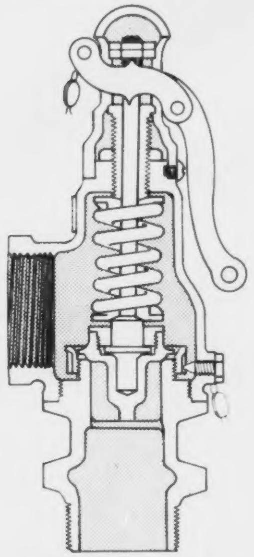
Swing Check Valve



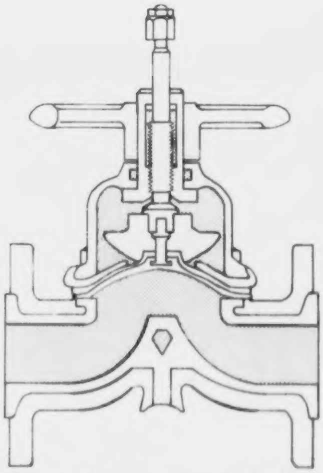
Lift Check Valve



Safety Valve



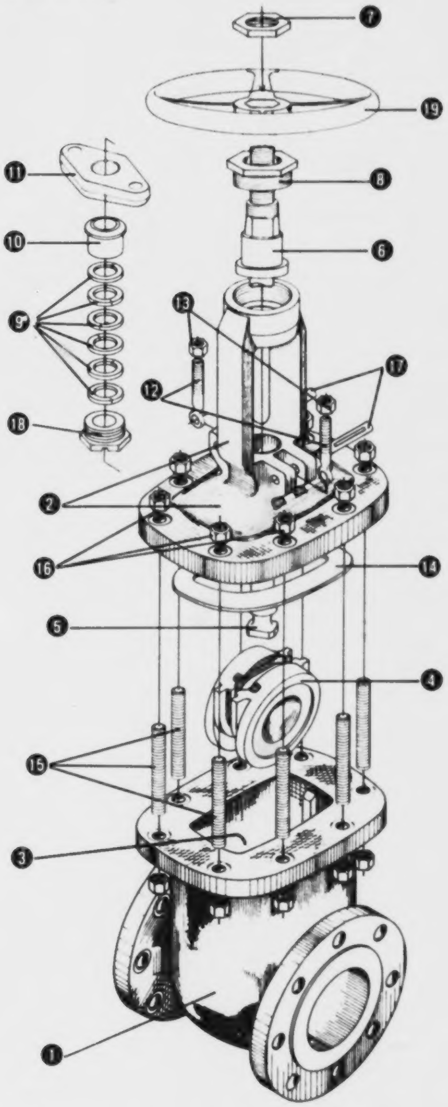
Relief Valve



Diaphragm Valve

Typical Bolted Bonnet Gate Valve

Crane gate valves offer the ultimate in dependable service for steam, air, gas, oil, oil vapor, and high pressure installation. All have straight-through ports to assure minimum turbulence, erosion, and resistance to flow, they are available in a wide variety of trims.



This illustration represents a typical Crane gate valve. It is not intended to show all the details and construction of all Crane gate valves.

1. **Body:** is cast to provide liberal strength to meet operating conditions and to permit unobstructed flow. Turbulence, erosion, and pressure drop are minimized.

   Flanged End: is illustrated here. Crane cast steel gate valves are also available with butt welding ends. All flanged and butt welding end valves are designed to conform to ANSI B16.5 and ANSI B16.34 standards.
2. **Integra Yoke & Bonnet:** is shown. Some designs incorporated a two-piece bonnet and yoke. All bonnet assemblies are cast and finished to the same exacting tolerances as the bodies for accurate alignment of stems and ease of sealing. Bonnet joint varies from flat face gasket-joint (shown) to ring-type bonnet joint, depending on Class.
3. **Seat Rings** (not illustrated) are seal welded to eliminate leak path behind rings and for long rouble-free service. The surfaces are precision ground to fit accurately with the disc. Seats are regularly furnished hard faced. All others are optional.
4. **Disc:** Crane's one-piece flexible disc is shown. The merits of this design are attested to by its many imitations. Basically, it provides accurate alignment of mating seating surfaces so the valve can absorb piping strains without leakage. Also, it avoids any tendency to stick in the seated position. Valves are also furnished with solid wedge discs that have proved successful in millions of applications.
5. **Stem:** The tee-head disc-stem connection prevents lateral strain on the stem for smooth, easy operation. Accurate cut threads engage the yoke sleeve for positive control of disc position.
6. **Yoke Sleeve**
7. **Handwheel Nut**
8. **Yoke Sleeve Retaining Nut**
9. **Packing:** contains corrosion inhibitor to avoid stem pitting. Stuffing box is deep, assuring long packing life.
10. **Gland:** is a two-piece ball-type which exerts even pressure on the packing without binding the stem.
11. **Gland Flange**
12. **Gland Eye Bolts:** swing aside for ease in repacking the stuffing box.
13. **Gland Eye Bolt Nuts**
14. **Bonnet Gasket:** seals joint from possible leakage.
15. **Bonnet Studs** } number is dependent on valve size
16. **Bonnet Nuts** } and class.
17. **Groove-Pin**
18. **Bonnet Bushing**
19. **Handwheel:** Crane gate valves can also be supplied with gear or motor operators.

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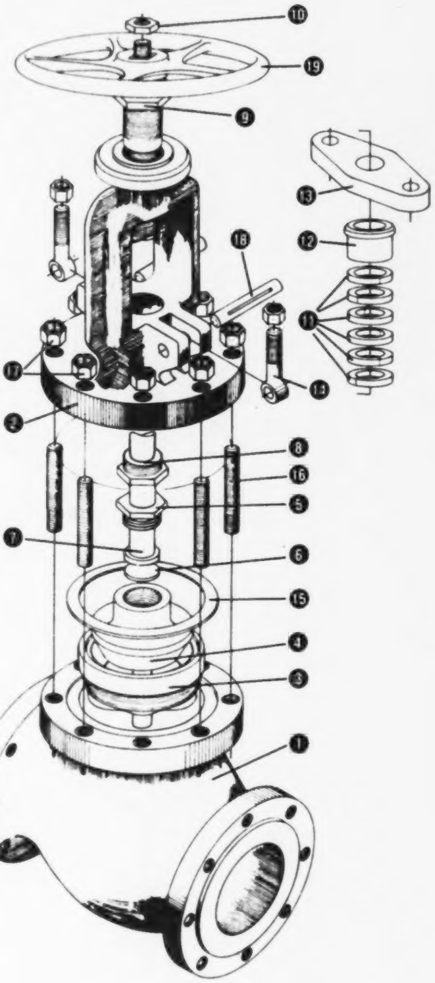
Typical Globe Valve

Crane globe valves are highly efficient for services requiring frequent operation and throttling when pressure drop across the valve is about 20% of inlet pressure. Closer throttling, creating higher pressure drops may cause cavitation or excessive velocities which could cause high noise levels, vibration and possible damage to the valve or adjacent piping. Globe valves can be equipped with optional operators. They are available with a variety of trims to match service requirements.

1. **Body:** is cast with heavy sections reinforced at points subjected to the greatest stress. Flanged end is shown, but Crane globe valves are also available with butt welding ends. All conform to ANSI specifications.
2. **Bonnet**
3. **Body Set Ring**
4. **Disc**
5. **Disc Stem Ring:** connects the disc to the stem, permitting the disc to swivel and aid in securing tight seating for trouble-free service.
6. **Disc Washer**
7. **Stem:** has long engagement with yoke bushing for accurate seating.
8. **Bonnet Bushing**
9. **Yoke Bushing**
10. **Wheel Nut**
11. **Packing**
12. **Gland:** is a two-piece, ball-type which exerts even pressure on the packing without binding the stem.
13. **Gland Flange**
14. **Gland Eye Bolts:** are securely fastened to the bonnet yet swing away to permit easy access to the stuffing box.
15. **Bonnet Gasket:** provides a positive seal against leakage. Class 150 and 300 valves have a male/female bonnet joint. A ring-type gasket is employed in Class 600, 900, and 1500 valves.
16. **Bonnet Studs**
17. **Bonnet Nuts**
18. **Groove-Pin**
19. **Bonnet Bushing**



This illustration represents a typical Crane globe valve. It is not intended to show all the details and construction of all Crane globe valves.

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Typical Swing Check Valve

Check valves are automatically actuated. They are opened and sustained in the open position by the force of velocity pressure, and closed by the force of gravity. Seating load and resultant tightness is dependent upon back pressure. The disc and associated moving parts may be in a constant state of movement if the velocity pressure is not sufficient to hold the valve in a wide open and stable position. Premature wear and noisy operation or vibration of the moving parts can be avoided by selecting the size of check valve on the basis of flow conditions. The minimum velocity required to hold a swing check valve in the wide open and stable position has been developed by analysis of extensive test data and is expressed by the formula:

$$\nu = 60\sqrt{\bar{v}}$$

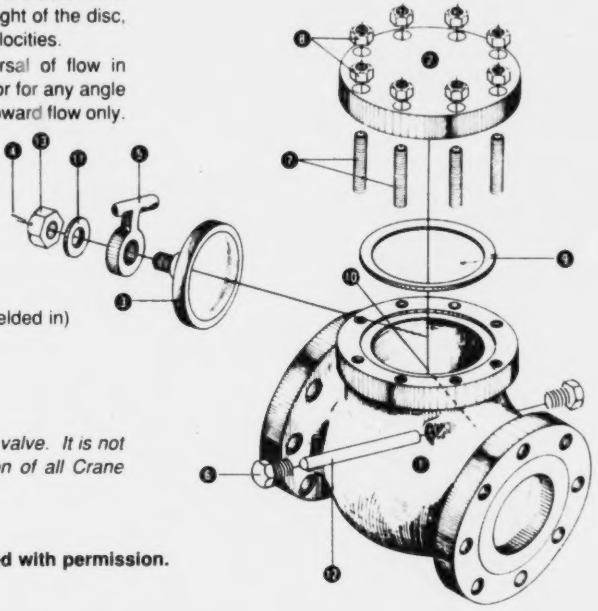
ν is equal to flow in feet per second and $\bar{v}$ is the specific volume of the fluid in cubic feet per pound. Sizing swing check valves on this basis may often result in the use of valves that are smaller than the pipe in which they are used, necessitating the use of reducers for installation. The pressure drop will be no greater than that of the larger valve that is only partially open, and valve life will be greatly extended. The added bonus, of course, is the lower cost of the smaller valve.

There is no tendency for the seating surfaces of swing check valves to gall or score, because the disc meets the flat seat squarely without rubbing contact upon closing. The regularly furnished "X" or "XU" trim is therefore suitable for all services that require U trim at temperatures to 1100 F. "A" and "L" or "AU" and "LU" trims are also available when specified.

Crane cast steel swing check valves can be furnished with outside lever and adjustable weight when so ordered. With the lever and weight mounted so that the weight assists the disc in closing, the valve closes more rapidly when flow stops, thus minimizing reversal of flow and resultant surge and shock. With the lever and weight mounted to balance the weight of the disc, the valve becomes more sensitive to low inlet velocities.

Swing check valves are used to prevent reversal of flow in horizontal or vertical pipe lines. In vertical lines, or for any angle from horizontal to vertical, they can be used for upward flow only.

1. **Body:** Strong construction assures masimum safety over the recommended pressure and temperature range. Both flange and butt weld ends are available.
2. **Cap:** Permits access to hinge and disc without removing valve from line.
3. **Disc:** Designed to close on its own weight to stop backflow from gaining sufficient velocity to create damaging shock.



4. Disc Nut Pin
5. Hinge
6. Hinge Pin Plugs
7. Cap Studs
8. Cap Stud Nuts
9. Gap Gasket
10. Body Seat Ring (welded in)
11. Disc Washer
12. Hinge Pin
13. Disc Nut

This illustration represents a typical Crane check valve. It is not intended to show all the details and construction of all Crane globe valves.

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Tilting Disc Check Valve

Tilting Disc Check Valves consist essentially of a cylindrical housing, with a pivoted circular disc. The pivots are located just above the center of the disc, and offset from the plane of the body seat. This design gives a bell-crank action to the disc. The seat is of circular bevel type and the disc drops in or out of contact without rubbing or sliding.

Features:

Slamming of check valves is the result of failure of the valve disc to reach its closed position before the fluid flow reversal. Tilting disc check valves have the ability to close rapidly since the disc has a shorter distance to travel and therefore arrives at the seat faster…minimizing a slam.

Tilting disc check valves are used to prevent reversal of flow in horizontal or vertical pipe lines. In vertical lines, or for any angle from horizontal to vertical, they can be used for upward flow only.

Tilting check valves are automatically actuated. They are opened by velocity pressure, and closed by gravity. Seating load and tightness is dependent on back pressure. The disc and moving parts may constantly move if the velocity pressure is not sufficient to hold the valve in a wide open and stable position. Premature wear and noisy operation or vibration of the moving parts can be avoided by selecting the size of check valve on the basis of flow conditions. The minimum velocity required to hold a tilting disc check valve wide open and stable can be determined by formula:

$$\nu = 80\sqrt{\bar{v}}$$

ν is equal to flow in feet per second and where $\bar{v}$ is the specific volume of the fluid in cubic feet per pound. Sizing check valves on this basis may often result in the use of valves that are smaller than the pipe in which they are used, necessitating the use of reducers for installation. The pressure drop will be not greater than that of the larger valve that is only partially open, and valve life will be greatly extended. The added bonus, of course, is the lower cost of the smaller valve.

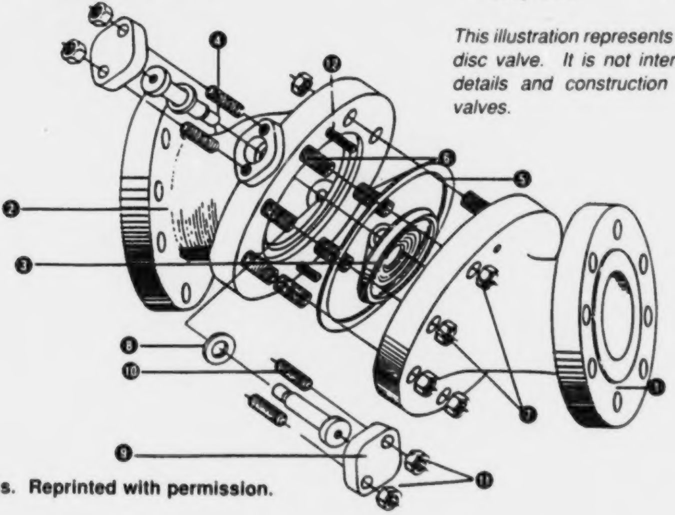
Standard body design configurations:

The seat, disc and pivot pins are combined into one sub-assembly secured to the inlet side of the body with a locking ring in sizes 3" and smaller. This construction avoids the need for extending the pivot pins through the valve body.

The seat is formed on the end of the inlet body section by cobalt base alloy hard facing deposit in sizes 4" and larger. The pivot pins supporting the disc are inserted through capped and gasketed bearing bosses in the outlet section of the body.

1. Body Inlet Half
2. Body Outlet Half
3. Disc
4. Pivot Pin
5. Body Gasket
6. Body Studs
7. Body Stud Nuts
8. Bearing Cap Gasket
9. Bearing Cap
10. Bearing Cap Studs
11. Bearing Cap Stud Nuts
12. Dowel Pins

This illustration represents a typical Crane tilting disc valve. It is not intended to show all the details and construction of all Crane globe valves.



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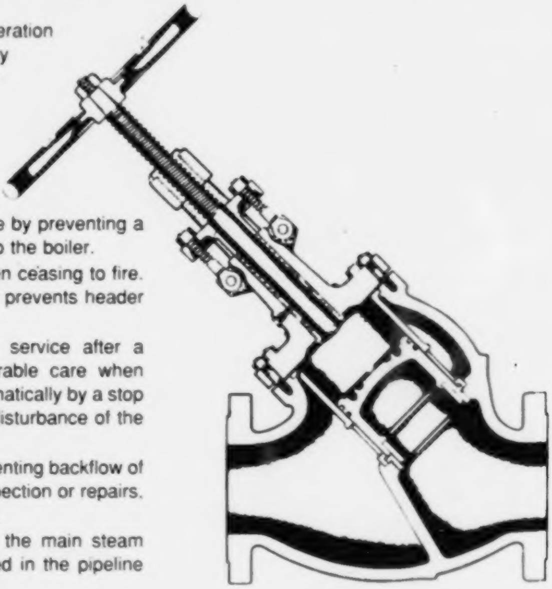
Typical Stop Check Valve

Stop Check valves are as essential to safe operation of a boiler plant as safety valves or other safety devices attached to the boiler. The valves are intended to perform four important functions in boiler steam piping.



This illustration represents a typical Crane stop check valve. It is not intended to show all the details and construction of all Crane globe valves.

First: To act as an automatic non-return valve by preventing a backflow steam from the main steam header to the boiler.

Second: To assist in cutting out a boiler, when ceasing to fire. In this case, the disc automatically closes and prevents header pressure from entering the boiler.

Third: To assist in bringing a boiler into service after a shutdown. This operation requires considerable care when performed manually, but is accomplished automatically by a stop check valve, without pressure fluctuations or disturbance of the water level.

Fourth: To act as a "safety first" valve by preventing backflow of steam from the header or for shutdown for inspection or repairs, should an attendant accidently open the valve.

When more than one boiler is connected to the main steam header, a stop check valve should be installed in the pipeline between each boiler and the header.

The valve should always be placed so that the pressure in the boiler is under the disc. Straightway valves may be used in horizontal or vertical lines for upward flow. Angle valves may be used for upward horizontal or horizontal downward flow. See Engineering Data catalog for typical installations.

Features:

Cylindrical-Shaped Disc — is the only moving part. It is especially designed to produce maximum lift at minimum velocities. There are no wing guides to cause "spinning" with resultant rapid wear.

Long Throttling Lip on the disc retards flow when seating position is approached. Disc chattering is prevented, and wire-drawing of seating surfaces is reduced.

Removable Liner guides the disc throughout the full travel. Being entirely independent of the body, it is not subject to distortion by expansion strains.

Piston Ring adds to dashpot's ability to avoid rapid disc movement and where pulsations are extremely severe, two piston rings can be installed.

Easy Regrinding tap bosses on top of the disc permit inserting nipples or eye bolts to facilitate quick removal of the disc for grinding.

Large Port Areas in the liner produce only a minimum of pressure drop through the valve and assure unrestricted movement of the disc.

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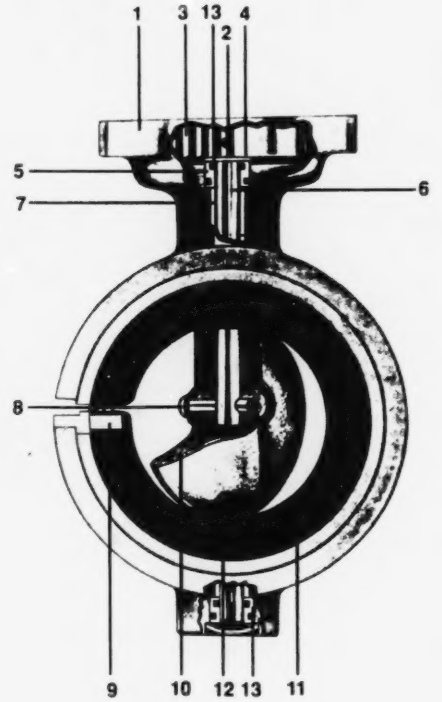
Monarch Butterfly Valves

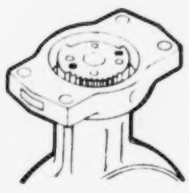
Comply with MSS-SP-67, API 609* and AWWA C504 Class 150B**



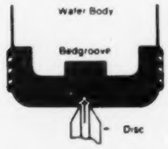
1. Neck flange provides rugged operator base.
2. Safety shear pin protects against valve damage due to excessive torque.
3. Universal stem coupling which permits interchanging of operators. Extended neck design assures ample clearance for operating mechanism in insulated pipelines.
4. Nylon friction washer eases operation.
5. Phenolic retainer with double O-rings prohibits entry of atmosphere and foreign matter...provides a supplementary stem seal.
6. Solid, one-piece stem is ground and polished. Uniform bearing load prevents uneven wear. Full AWWA diameter for ENTIRE length assures high safety factor.
7. Reinforced bearings encircle upper and lower portions of stem, contribute to proper stem alignment and low torque operation.
8. Corrosion-resistant spiral pin secures disc to stem. The spiral pin is stronger and more resistant to vibration than solid taper pins or cap screws. A stainless steel welch plug, force-fitted, seals disc cavity.
9. Cartridge-type seat (liner) is bonded to a rigid phenolic back-up ring. Easily replaced in field if every necessary. The back-up ring prohibits the seat from shifting when disc is operated.
10. Disc is designed for low flow resistance. Bored straight-thru for accurate stem alignment.
11. On wafer and lug wafer valves, seat is lapped over both faces of body. The portion lapped over consists of heavy, multiple ribs of buttressed design (see sketch below) which serves as a gasketed seal between valve and pipe flanges.
12. No leakage around stem. Primary seal effected by flats on disc and seat, with same impingement as at disc edge. Back-up protection provided by cone-shaped stem hole seal (see sketch below).
13. Sizes 8″ and larger feature two O-ring seals below (as well as above) disc.

* Except for laying length on 16″ and 18″ wafer and lug wafer.

** Except for laying length on Wafer and Luf Wafer. Order should indicate AWWA requirement.



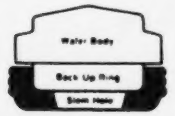
Universal stem coupling permits interchanging Crane operators...with no need for separate adapter.



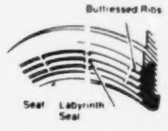
14″ thru 24″ size seat design with molded in liner.

Bedgroove and disc impingement.

Extra seat thickness for greater retained resiliency and longer seat life.



Cone-shaped stem holes through the seat and an EPT O-ring provide a pressure-tight stem seal.



Labyrinth seal and buttressed ribs.

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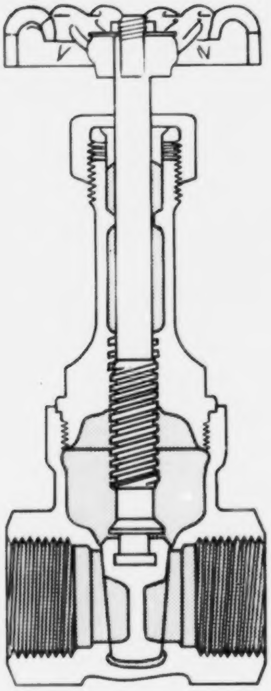
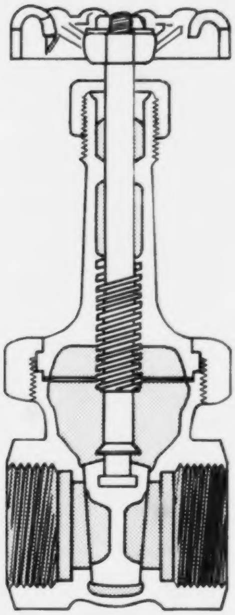
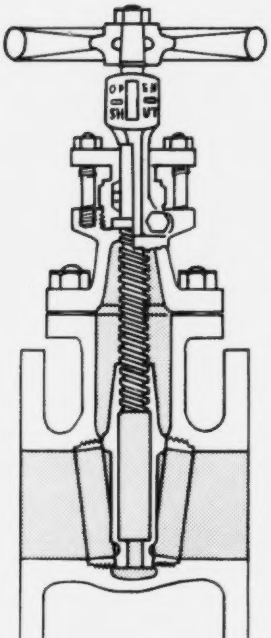
Bonnet Assemblies



Screwed

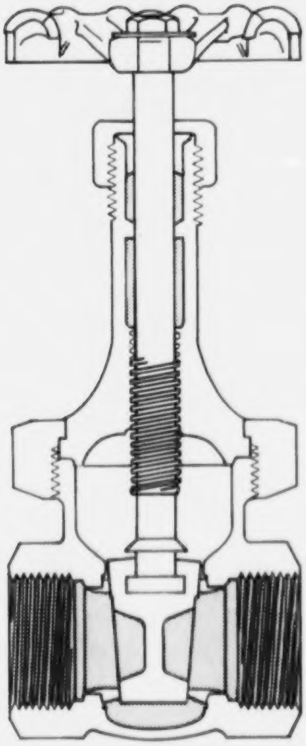


Screwed Union

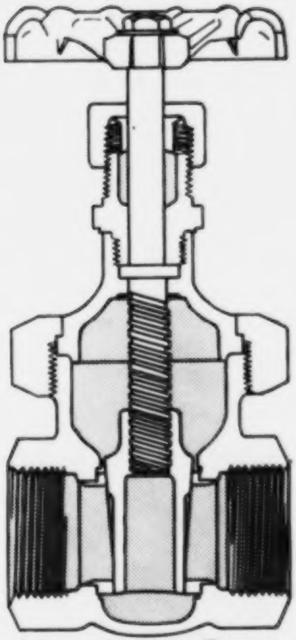


Bolted

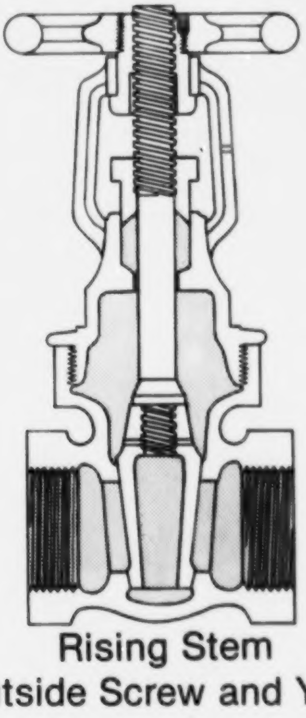
Types of Stems



Rising Stem
Inside Screw

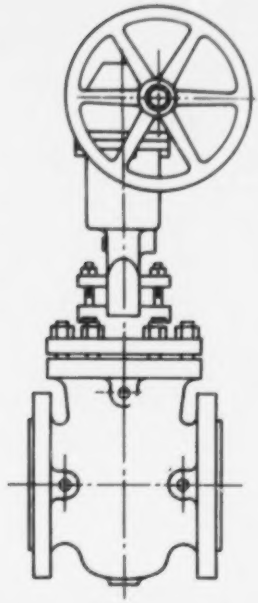


Nonrising Stem
Inside Screw

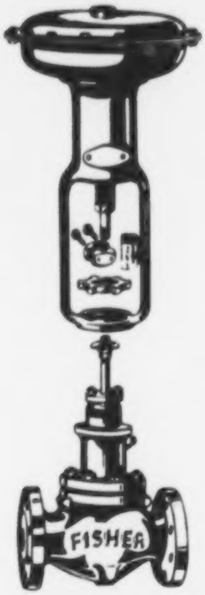


Rising Stem
Outside Screw and Yoke

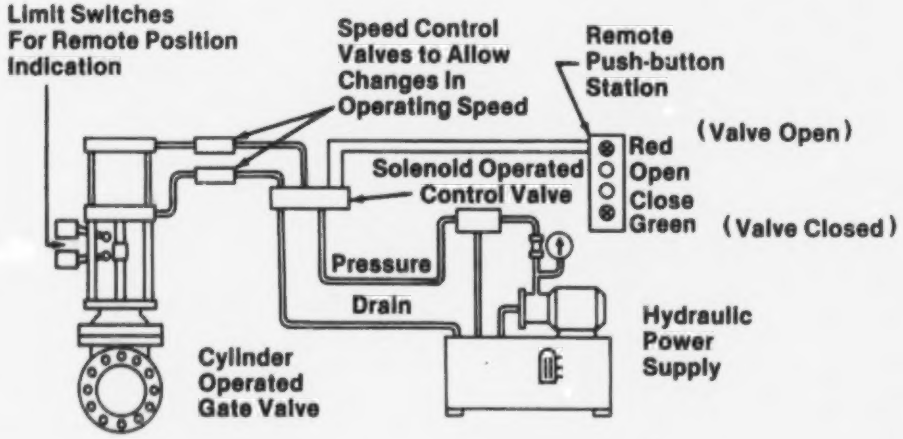
Methods of Valve Operation



Gear Operated

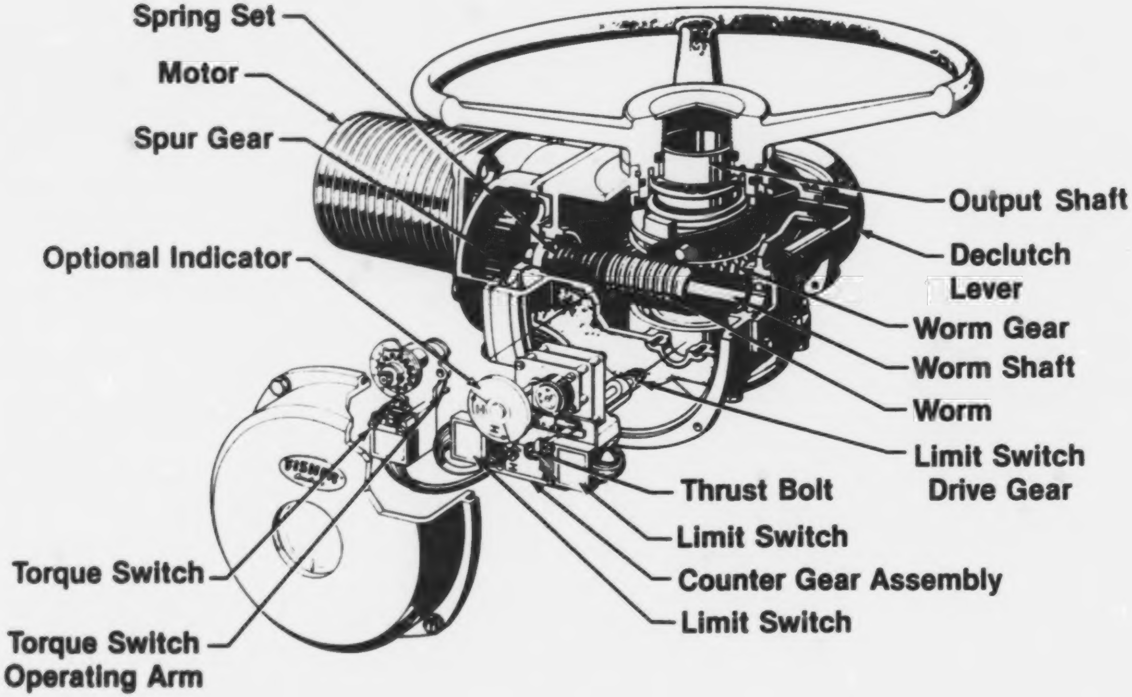


Diaphragm Operated


Limit Switches
For Remote Position
Indication
Speed Control
Valves to Allow
Changes in
Operating Speed
Remote
Push-button
Station
Red
(Valve Open)
Open
Close
Green
(Valve Closed)
Solenoid Operated
Control Valve
Pressure
Drain
Hydraulic
Power
Supply
Cylinder
Operated
Gate Valve

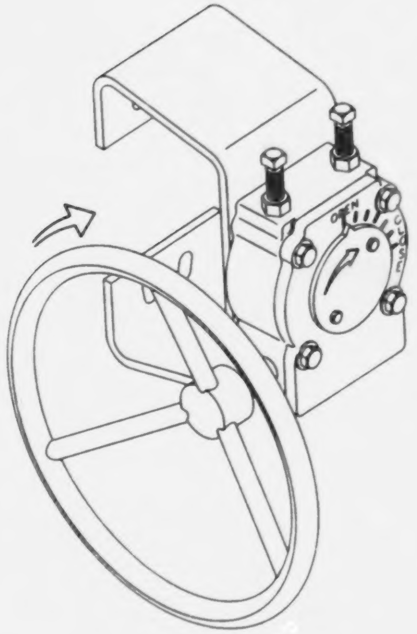
Cylinder Operated

Electromechanical Actuator

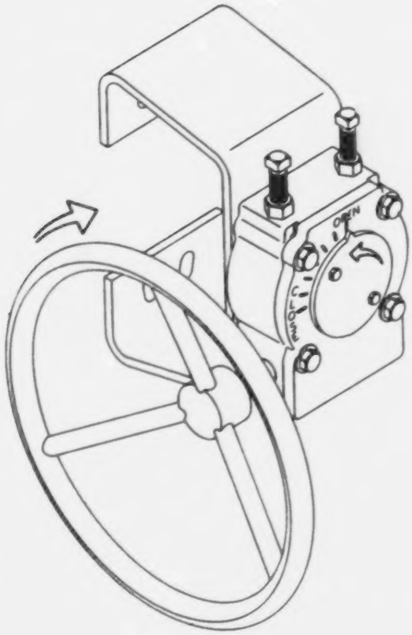

Spring Set
Motor
Spur Gear
Optional Indicator
Output Shaft
Declutch Lever
Worm Gear
Worm Shaft
Worm
Limit Switch Drive Gear
Thrust Bolt
Limit Switch
Counter Gear Assembly
Limit Switch
Torque Switch
Torque Switch Operating Arm

Courtesy Fisher Controls Company

Handwheels



Direct Acting



Reverse Acting

Direct Acting: Clockwise rotation of the handwheel produces clockwise rotation of the valve shaft.

Reverse Acting: Clockwise rotation of the handwheel produces counterclockwise rotation of the valve shaft.

Courtesy Fisher Controls Company

Valves
Unit 4

Information Sheet

1. **Terms and definitions**

   a. **Alloy** — A substance composed of two or more metals to produce a desired quality of metal, used to make valve components

   b. **Actuator** — A device that will operate a valve, either opening or closing by remote control

   c. **Bonnet** — Part of a valve which covers the internal moving parts, contains a means of sealing the stem against leakage, and provides a means for attaching an actuator

   d. **Critical Service** — Valves that operate under high pressure, high temperature, and fire or other hazardous situations

   e. **Disc** — Valve component which initiates, shuts off, or regulates flow

   f. **Malleable Iron** — Cast iron which has been heat treated to relieve brittleness and improve tensile strength

   g. **Noncritical Service** — Valves that operate under low pressure to moderate pressure situations

   h. **Ports** — Valve inlet and outlet openings

   i. **Stem** — Valve component which moves the disk on and off the valve seat, can be manually, pressure, or actuator controlled

   j. **Thermal Shock** — Valve stress caused by sudden rise or drop in temperature of the fluid in contact with the valve

   k. **Throttling** — Controlled restriction of flow rate to maintain temperature or pressure

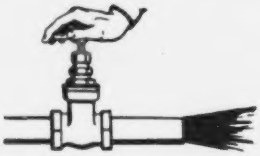
   l. **Trim** — Internal valve components such as seat rings, discs, stems, etc. which can be replaced during maintenance

Information Sheet

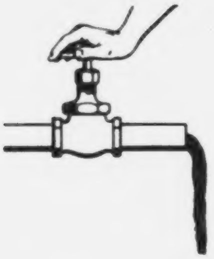
2. Primary functions of Valves

Note: In any fluid handling system, valves are the controlling element; they have five primary functions.

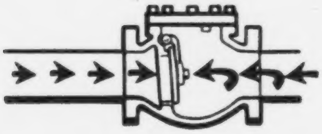
a. Start and Stop flow (often a gate valve)



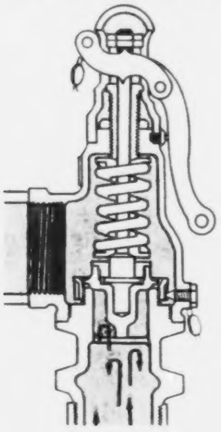
b. Regulate or Throttle flow (often a globe valve)

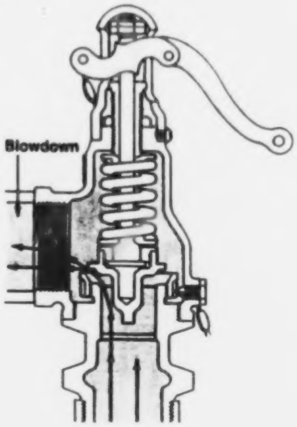


c. Prevent Backflow (usually a check valve)



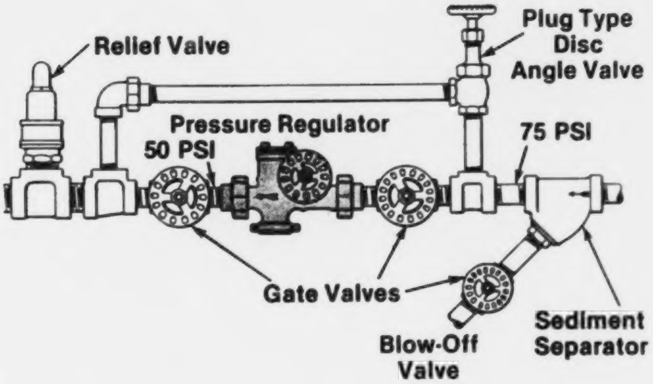
d. Relieve Pressure (usually a relief valve)





Information Sheet

e. Regulate Pressure (valves in combinations)


Relief Valve
Plug Type Disc Angle Valve
Pressure Regulator
50 PSI
75 PSI
Gate Valves
Blow-Off Valve
Sediment Separator

3. Basic Parts of a Valve

Note: Valves vary considerably in construction between types of valves and manufacturers, however all valve components can be classified into five major parts.

a. **Body** — A housing with inlet and outlet flow connections that serves also to house internal parts

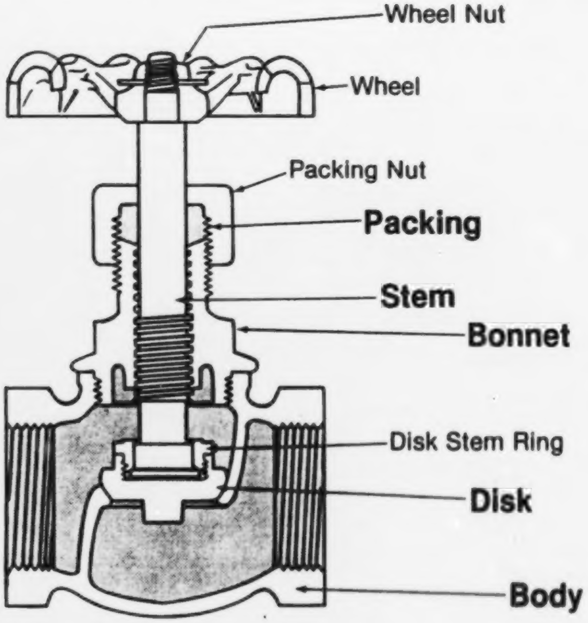
b. **Bonnet** — Part of a valve which covers the internal moving parts, contains a means of sealing the stem against leakage, and provides a means for attaching an actuator

c. **Disc** — Valve component which initiates, shuts off, or regulates flow

d. **Stem** — Valve component which moves the disk on and off the valve seat, can be manually, pressure, or actuator controlled

Information Sheet

e. **Packing** — Material inserted around a valve plug stem to prevent leaking


Wheel Nut
Wheel
Packing Nut
Packing
Stem
Bonnet
Disk Stem Ring
Disk
Body

Globe Valve With Screwed Bonnet

4. **Gate valves and their characteristics**

   a. Gate valves are efficient stop valves because flow can move in either direction.

   b. Gate valves function best when fully open or fully closed.

   c. When they are fully open, gate valves offer little resistance to flow, and are commonly used in applications where minimum pressure drop is important.

   d. Gate valves are not recommended for throttling service.

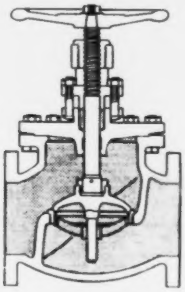
   Note: Refer to TM 5 and Student Supplement 2.

Information Sheet

5. Globe valves and their characteristics

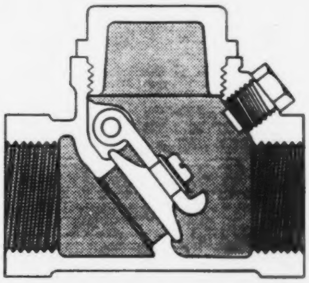
a. Because globe valves have characteristics that permit accurate and repeatable flow control, they are ideal for throttling service.

b. Globe valves can be subject to excessive noise, vibration, and even damage when applications call for extremely close throttling.

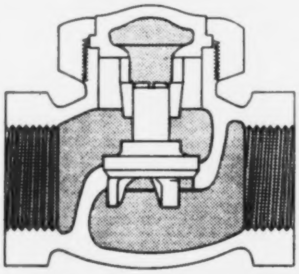


6. Types of check valves and their characteristics

a. **Swing check and lift check valves** — These types of check valves can be readily installed in both horizontal and vertical flow applications because they offer low resistance to flow and are well suited to low-velocity service.



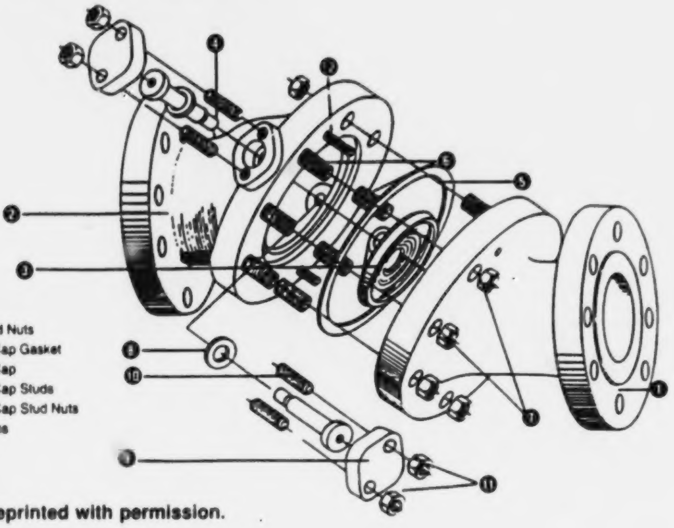
Swing Check Valve



Lift Check Valve

Information Sheet

b. **Tilting disc check valves** — These types of check valves have a design modification that tilts the shut-off disc to reduce noise and vibration caused by the slamming effect when flow is reversed.



1 Body Inlet Half
2 Body Outlet Half
3 Disc
4 Pivot Pin
5 Body Gasket
6 Body Studs
7 Body Stud Nuts
8 Bearing Cap Gasket
9 Bearing Cap
10 Bearing Cap Studs
11 Bearing Cap Stud Nuts
12 Dowel Pins

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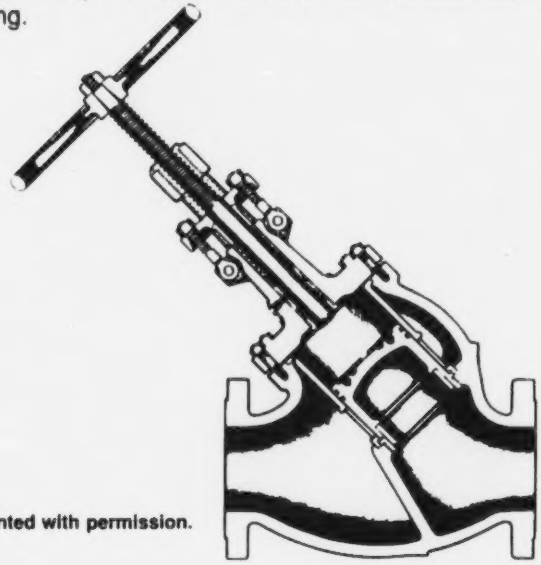
c. **Stop check valves** — These types of check valves have no mechanical connection between the stem and the disc; they are used in steam boiler outlet piping when two or more boilers are connected to a common header to prevent steam backflow from the header to the boiler.

Note: Check valves must be installed with pressure under the disc so that when the stem is raised, only boiler pressure can raise the disc; these valves should not be used for throttling.



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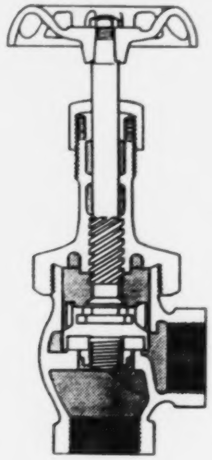
Information Sheet

7. Angle valves and their characteristics

a. Except for the fact that line fluid takes a 90° turn, angle valves have a design similar to globe valves and are used for the same applications as globe valves.

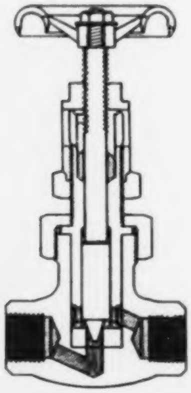
b. The angle valve eliminates the need for a globe valve plus a 90° elbow, but they should not be used in critical service applications.



8. Needle valves and their characteristics

a. Needle valves are small and compact and can be used for small quantity measurement of high temperatures and high pressures.

b. Needle valves are used for throttling and for exact flow regulation.

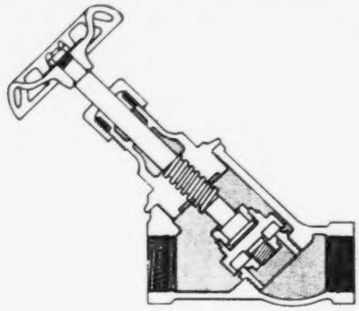


Information Sheet

9. Y-Pattern valves and their characteristics

a. Y-pattern valves have quick operating characteristics and that is why they are used primarily for throttling.

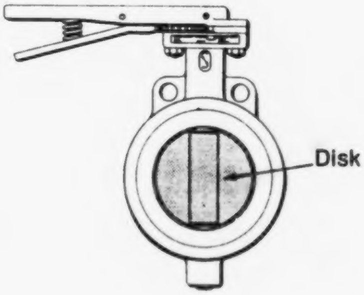
b. The Y-pattern design offers less resistance to fluid flow, and affords less of a pressure drop than standard globe valves.



10. Butterfly valves and their characteristics

a. Butterfly valves are popular for on/off throttling applications because they are light weight and require minimal installation space.

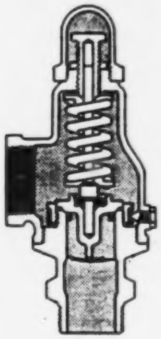
b. The valve liner material in butterfly valves will not permit their use in extreme temperature applications.



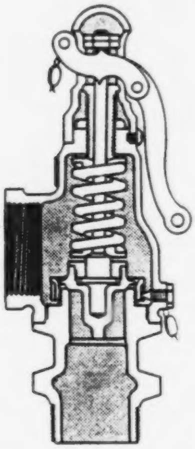
Information Sheet

11. Safety and relief valves and their characteristics

a. Safety valves, sometimes called "pop-off" valves, are used strictly to relieve pressure in steam, air, or gas lines, but they are never used on liquid lines.



b. Relief valves are also called "pop-off" valves, but they are designed for use on liquid lines, and their design usually diverts relieved liquid into another line or holding tank.

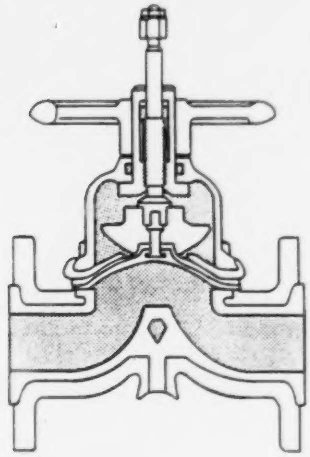


Information Sheet

12. Diaphragm valves and their characteristics

a. As the word "diaphragm" indicates, diaphragm valves have a flexible disc that can be used to turn off/turn on flow, or used for throttling.

b. The design provides a leakproof closure affording little change for contaminating the line substance, but the flexible disc should not be used in high temperature applications.



13. Ball valves and their characteristics

a. Ball valves have a design that permits quick, quarter-turn operation.

b. Ball valves have smooth flow characteristics because the design is non-sticking, self-sealing, and compact.

c. Ball valves are also available in various port designs such as venturi port, full port, or reduced port.

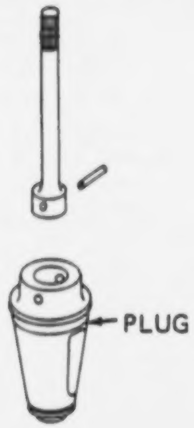
Note: Refer to TM 5.

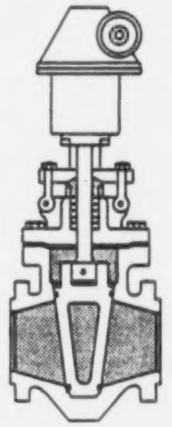
Information Sheet

14. Plug valves and their characteristics

a. Sometimes referred to as "cock" valves, plug valves are used for quick on/off applications.

b. The quick, quarter-turn action of a plug valve seals better than a gate valve, and is ideal for slurry material because fluids cannot enter the valve body cavity.





15. Applications of steel and steel alloys

a. Steel and steel alloys are used for high temperatures and high pressure applications that are too severe to cast iron, bronze, or brass.

b. Steel and steel alloys are superior to cast iron, bronze, and brass because of their toughness and ability to resist strain, vibration, shock, low temperature, and fire damage.

Information Sheet

c. Steel and steel alloys are cast for larger sizes and forged for smaller sizes.

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1992

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Materials of Construction

Steel bolted bonnet valves described in this catalog are regularly made in carbon steel. When specified, the valves are available in the alloys shown below which are suitable for steam, water, oil, oil vapor, gas, and general services. Please contact Crane Co. for availability and material breakdowns.

Body and Bonnet or Cap Materials

Crane Designation	Cat. no. Suffix	ASTM Spec.	Material Classification	Service Recommendations
Carbon Steel	None	A216 GR. WCB	Carbon Steel	Steam, water,oil, oil vapor, gas, and general services at temperatures -20 to 1000 F. (1) (4) (5)
			5% Cr, ½% Mo	Corrosive-erosive Oil Refinery Service at temperatures -20 to 1100 F. (2)
			1¼% Cr, ½% Mo 2¼% Cr, 1% Mo	Steam, water, oil, oil vapor, gas, general services at temperatures -20 to 1100 F. (3) (4) (5)
			Low Carbon Steel	Low Temperature Service to -50 F. Not for use above 650 F.
			3½% Nickel Steel	Low Temperature Service to -150 F. Not for use above 650 F.

(1) Valves regularly rated at 850F maximum upon prolonged exposure to temperatures above approximately 800F, the carbide phase of carbon steel may be converted to graphite

(2) Valve regularly rated to 1000F

(3) Considerations should be given to the possibility of excessive oxidation (scaling) when used above 1050F

(4) Product used within the jurisdiction of Section 1. Power Boilers, of the ASME Boiler and Pressure Vessel Code, is subject to the same temperature limitations placed upon the material in Table PG-23.1

(5) Product used within the jurisdiction of Power Piping, ANSI Code for Pressure Piping, B31.1, is subject to the same maximum temperature limitations placed upon the material in paragraph 123.2

Information Sheet

16. Valve body materials and their characteristics

a. **Brass** — A copper and zinc alloy that is used for noncritical service at temperatures below 400°F and low pressures

b. **Bronze** — A copper and tin alloy that is used for temperatures up to 500°F and pressure up to 300 psi

c. **Iron** — Available in three grades as cast iron, ferrosteel, or high-tensile iron for temperatures up to 450°F

d. **Malleable iron** — Used for piping materials subject to expansion and contraction, and stresses and shock because it exhibits characteristics of tightness, stiffness, and toughness

17, Types of bonnet assemblies and their applications

a. **Screwed bonnets** — Normally used on smaller valves in non-critical service; this is the least expensive of all bonnet designs and not recommended for frequent dismantling

b. **Bolted bonnets** — Recommended for critical service; come in larger sizes and are easily dismantled

c. **Screwed union bonnets** — Normally used on smaller valves in critical service; no problems with dismantling under normal operating conditions

18. Inlet/outlet connections and their applications

a. **Welded ends** — For critical service for applications which require infrequent dismantling

b. **Flanged ends** — For critical service for applications which do require frequent dismantling

c. **Screwed or threaded ends** — For smaller pipes in ordinary pressure applications; easily fitted into original equipment installations

d. **Soldered and socket-brazed ends** — For nonflammable applications on copper or red brass piping

Information Sheet

19. Types of stems and their characteristics

a. **Rising stem** — Requires adequate headroom; stem position indicates disc position

b. **Nonrising stem** — Requires less headroom; stem position does not indicate disc position

c. **Inside screw** — Used primarily for smaller valves; threads that control disc location are inside the bonnet and the stem threads are subject to thermal shock

d. **Outside screw** — Threads that control disc location are outside the bonnet, and position indicates disc position; stem threads are not subject to thermal shock

20. Types of valve actuators

a. Valves can be opened and closed manually or mechanically with valve actuators.

b. Manual actuators include handwheels for smaller valves and gear-operated actuators for larger valves.

c. Mechanical actuators can be controlled with diaphragms, gears, or cylinders.

d. Mechanical actuators are often driven by a motor, and the motor signal may be transferred with air pressure or vacuum, an electrical signal, or fluid pressure.

21. Factors to consider in actuator selection

a. Know the size and type of valve.

b. Know the required opening and closing times.

c. Know the valve operating pressure.

d. Determine if the actuator environment is affected by a corrosive atmosphere, high temperature, or excessive moisture.

e. Determine if the operation is local or remote.

f. Determine what motive force will operate the actuator; electric, pneumatic, or hydraulic force.

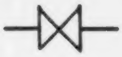
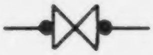
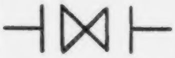
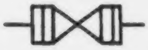
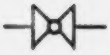
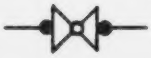
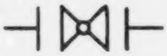
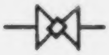
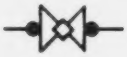
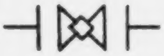
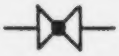
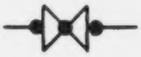
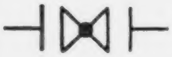
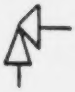
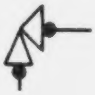
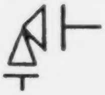
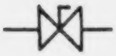
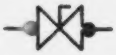
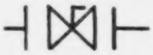
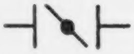
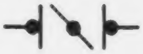
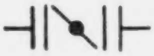
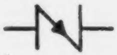
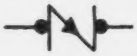
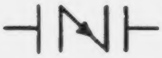
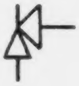
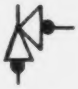
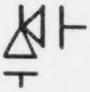
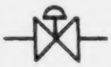
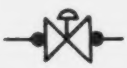
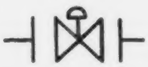
g. Gather electric actuator information to include: operating and control voltage and phases available, type of motor and whether it is explosion proof or totally enclosed, and other features such as position indicators, position lights, push button station, or an integral starter package.

h. Gather pneumatic actuator information to include: air supply pressure, pilot operation requirements, filter and lubricator types, solenoid valves, and limit switch operation.

Information Sheet

22. Basic threaded, welded, and flanged valve symbols

Note: The following chart displays basic standard symbols, but practices do vary from company to company.

	Threaded	Welded	Flanged
a. Gate			 or  (NOTE: Flanged valves may be shown either of these ways.)
b. Ball			
c. Plug			
d. Globe			
e. Angle			
f. Needle			
g. Butterfly			
h. Check			
i. Relief			
j. Control			

Information Sheet

23. Abbreviations for describing valve body materials

a. **AI** — All iron

b. **AL** — Aluminum

c. **BR** — Bronze

d. **CI** — Cast iron

e. **Cr** — Chromium

f. **CS** — Cast steel

g. **DI** — Ductile iron

h. **FS** — Forged steel

i. **IBBM** — Iron body bronze mounted

j. **MI** — Malleable iron

k. **Mo** — Molybdenum

l. **N** — Nickel

m. **PVC** — Polyvinyl chloride

n. **SS** — Stainless steel

o. **Tef** — Teflon

24. Abbreviations for valve pressure ratings

a. **CWP** — Cold working pressure

b. **SP** — Steam pressure

c. **WOG** — Water, oil, gas pressure

d. **WP** — Working pressure

e. **WSP** — Working steam pressure

Information Sheet

25. **Abbreviations for operating mechanisms**
    a. **NRS** — Nonrising stem
    b. **OS&Y** — Outside screw and yoke
    c. **RS** — Rising stem
26. **Abbreviations for facings, disks, and joints**
    a. **DD** — Double disk
    b. **FF** — Flat face
    c. **RF** — Raised face
    d. **RTJ** — Ring-type joint
27. **Abbreviations for end connections**
    a. **BW** — Butt welded ends
    b. **FE** — Flanged ends
    c. **FFD** — Flanged, faced, and drilled ends
    d. **SE** — Screwed ends
    e. **SJ** — Soldered ends
    f. **SW** — Socket welded ends

Valves
Unit 4

CRANE
STEEL
300

No. 159

Student Supplement 1—Valve Data

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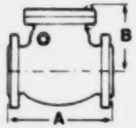
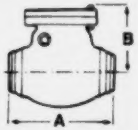
Swing Check Valve, 2" to 24", Class 150, Bolted Cap
No. 147, Flanged, No. 147 1/2, Butt Welding
Pressure-Temperature Rating Carbon Steel, ASTM A216 Grade WCB
285 psi -20F to 100F
Swing Check Valve, 2" to 24", Class 300, Bolted Cap
No. 159, Flanged, No. 159 1/2 Butt Welding
Pressure-Temperature Rating Carbon Steel, ASTM A216 Grade WCB
740 psi -20F to 100F



Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches		Valve Size	Weight—Pounds		Dimensions—Inches	
	147	147½	A	B		159	159½	A	B
			147 & 147½					159 & 159½	
2	33	26	8.0	6.75	2	46	33	10.50	6.75
2½	57	37	8.5	7.12	2½	66	49	11.50	7.38
3	59	40	9.5	7.38	3	86	66	12.50	8.50
4	93	71	11.5	8.50	4	154	97	14.00	9.25
5	152	126	13.0	9.50	5	255	203	15.75	10.62
6	165	132	14.0	10.25	6	276	216	17.50	11.88
8	275	235	19.5	11.88	8	420	330	21.00	13.38
10	440	385	24.5	13.88	10	640	500	24.50	13.88
12	680	570	27.5	15.75	12	1000	830	28.00	16.62
14	950	810	31.0	17.75	14	1550	1100	33.00	18.88
16	1225	1065	34.0	19.00	16	1700	1400	34.00	20.50
18	1700	1500	38.5	21.25	18	2200	1900	38.50	23.62
20	1850	1600	38.5	23.58	20	2800	2425	40.00	26.38
24	2900	2550	51.0	26.75	24	3650	3100	53.00	29.62

Student Supplement 1—Valve Data

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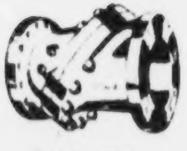
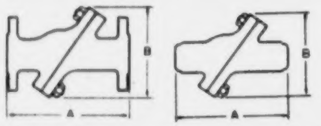
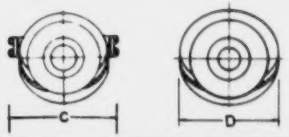


No. 123

Tilting Disc Check Valve, 2" to 36", Class 150
No. 123, Flanged, No. 123 1/2, Butt Welding
Pressure-Temperature Rating Carbon Steel, ASTM A216 Grade WCB
285 psi -20F to 100F
Tilting Disc Check Valve, 2" to 36", Class 300
No. 323, Flanged, No. 323 1/2 Butt Welding
Pressure-Temperature Rating Carbon Steel, ASTM A216 Grade WCB
740 psi -20F to 100F

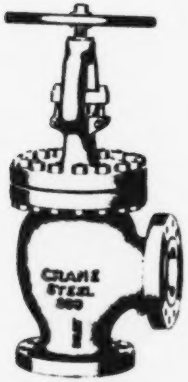


Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches				Valve Size	Weight—Pounds		Dimensions—Inches			
	123	123½	A	B	C	D		323	323½	A	B	C	D
2	38	22	8.0	7.31	—	7.94	2	57	38	10.5	8.06	—	8.50
2½	51	38	8.5	8.56	—	9.31	2½	85	58	11.5	9.50	—	9.88
3	59	42	9.5	8.56	—	9.31	3	90	60	12.5	9.50	—	9.88
4	102	75	11.5	9.88	13.25	—	4	167	106	14.0	10.75	14.25	—
5	139	108	13.0	11.25	15.62	—	5	215	166	15.75	12.50	16.38	—
6	175	140	14.0	13.50	17.00	—	6	270	200	17.5	14.50	17.75	—
8	293	240	19.5	15.88	20.75	—	8	457	338	21.0	17.00	22.00	—
10	488	400	24.5	18.75	25.00	—	10	670	520	24.5	20.25	25.12	—
12	690	570	27.5	21.38	27.75	—	12	1030	835	28.0	24.00	29.75	—
14	823	690	31.0	22.44	28.50	—	14	1245	1060	30.0	24.88	30.25	—
16	1070	885	30.0	24.94	34.00	—	16	1695	1270	33.0	27.81	36.00	—
18	1435	1213	33.0	27.75	35.75	—	18	2180	1685	36.0	30.75	39.50	—
20	1825	1760	32.5	30.62	38.88	—	20	2548	1850	39.0	32.50	40.75	—
24	2887	2265	38.0	35.82	44.62	—	24	4070	2790	45.0	37.50	45.25	—
30	4790	4025	49.5	43.50	53.75	—	30	6200	4652	54.0	44.50	53.75	—
36	6795	5755	59.5	50.00	60.25	—	36	11853	10000	60.0	56.38	68.00	—

*Weight on request



No. 160

Student Supplement 1—Valve Data

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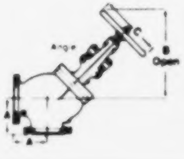
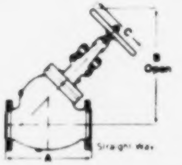
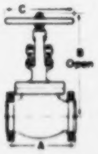
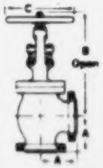
Stop Check Valve, 3″ to 10″, Class 300, OS&Y Bolted Bonnet
Glove Valves No. 28, Flanged, No. 28 1/2, Butt Welding
Angle Valves No. 30, Flanged, No 30 1/2 Butt Welding
Pressure-Temperature Rating Carbon Steel, ASTM A216 Grade WCB
740 psi -20F to 100F



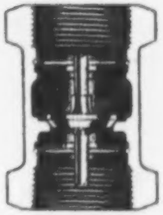


Weights and Dimensions





Valve Size	Weights—Pounds				Dimensions—Inches				
	28	28½	30	30½	A		B		C
					28 & 28½	30 & 30½	28 & 28½	30 & 30½	
3	140	125	120	90	14.75	6.25	21.5	16.5	10.0
4	260	225	200	160	17.00	7.00	26.5	21.0	14.0
6	430	395	370	320	21.50	8.75	33.5	26.5	18.0
8	770	755	680	570	26.00	10.50	40.5	32.0	20.0
10	1320	1265	1120	970	30.00	12.25	47.5	38.0	30.0



No. 29

Student Supplement 1—Valve Data
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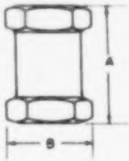
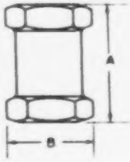
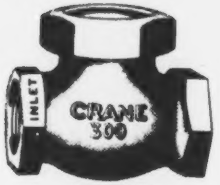
Lift Check Valves, 1/4″ to 3″, Class 125
Vertical Lift No. 29, Threaded



Weights and Dimensions



Valve N.P.S.	Weight—Pounds	Dimensions—Inches	
	29	29	
		A	B
¼	.3	1.95	1.09
⅜	.4	1.95	1.09
½	.6	2.15	1.29
¾	.8	2.32	1.57
1	1.4	2.92	1.92
1¼	2.1	3.28	2.40
1½	2.8	3.58	2.63
2	4.8	4.00	3.30
2½	8.1	4.94	3.97
3	12.0	5.42	4.78



No. 366E

Student Supplement 1—Valve Data

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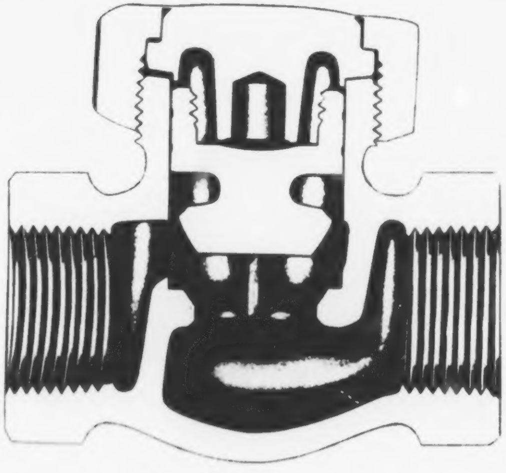
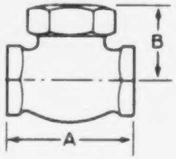
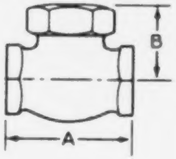
Lift Check Valves, 3/8″ to 2″, Class 300
No. 366E, Threaded



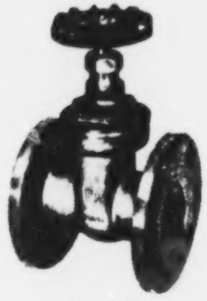
No. 366E



Weights and Dimensions



Valve N.P.S.	Weight—Pounds	Dimensions—Inches	
		A	B
⅜	0.6	2.00	1.12
½	0.9	2.50	1.38
¾	1.5	2.94	1.88
1	2.6	3.50	2.00
1¼	4.2	4.06	2.38
1½	5.4	4.62	2.62
2	10.8	5.75	3.25



No. 429

Student Supplement 1—Valve Data
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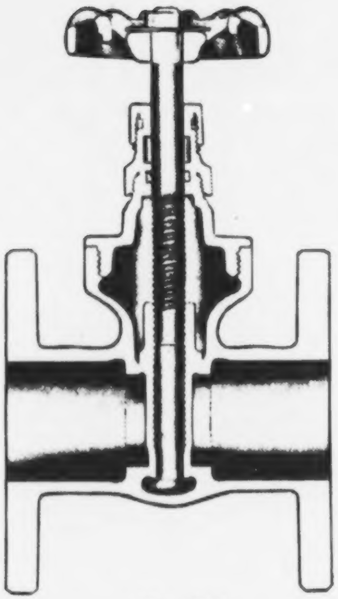
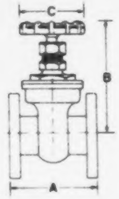
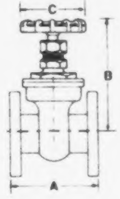
Flanged Gate Valves, 1″ to 3″, Class 150
Screwed Bonnet, Solid Wedge Disc, Non-Rising Stem
150 SQP/225 CWP, No. 429, Flanged



No. 429



Weights and Dimensions



Valve N.P.S.	Weight—Pounds	Dimensions—Inches		
		A	B	C
1	5.7	3.94	4.88	2.56
1¼	8.5	4.33	5.75	2.75
1½	11.1	4.72	6.50	3.06
2	17.8	5.32	7.44	3.62
2½	24.0	6.50	9.19	4.06
3	31.0	7.28	10.38	4.75

No. 384P

Student Supplement 1—Valve Data

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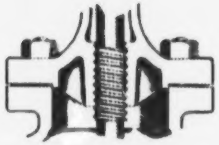
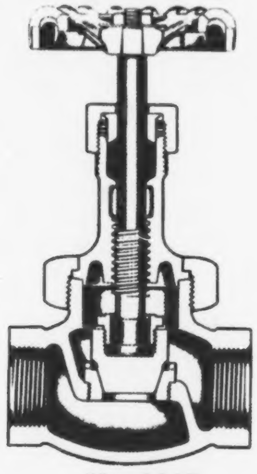
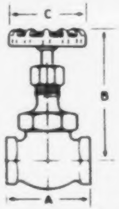
Globe and Angle Valves, 1/4″ to 3″, Class 300
Plug Type Disc, Union Bonnet
Globe No. 382P, Threaded, Angle No. 384P Threaded



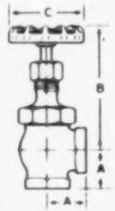
2½″ & 3″ size have a bolted bonnet



No. 382P



Weights and Dimensions



Valve N.P.S.	Weight– Pounds		Dimensions—Inches				
	382P	384P	A		B		C
			382P	384P	382P	384P	
¼	1.4	1.4	1.94	1.13	4.39	4.27	2.13
⅜	1.5	1.4	1.94	1.13	4.39	4.27	2.13
½	2.3	2.1	2.56	1.15	4.09	3.97	2.13
¾	2.8	3.3	2.96	1.39	4.18	4.03	3.03
1	4.3	5.0	3.50	1.64	5.45	5.30	3.03
1¼	8.1	7.7	4.02	2.00	6.36	6.11	3.72
1½	10.9	10.9	4.58	2.18	6.95	6.82	4.72
2	19.2	18.0	5.70	2.69	7.55	7.30	5.28
2½	34.4	—	7.25	—	8.92	—	7.00
3	48.1	—	8.50	—	10.16	—	7.00

"B" dimension is with valve open

No. 89

Student Supplement 1—Valve Data
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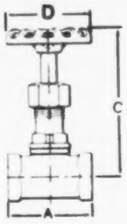
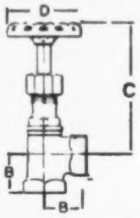
Needle Valves, 1/8" to 3/4", 200 SWP/400 CWP
Globe No. 88, Threaded, Angle No. 89 Threaded

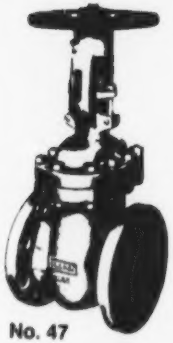


Weights and Dimensions



Valve N.P.S.	Weight Pounds	Dimensions—Inches				Bore Diameter
		A	B	C	D	
1/8	.3	1.16	.47	2.94	1.75	.13
1/4	.3	1.53	.78	2.88	1.75	.19
3/8	.5	1.78	.91	3.06	1.75	.25
1/2	.6	2.03	1.06	3.56	2.06	.31
3/4	1.0	2.28	1.25	4.12	2.56	.44

"C" dimension is with valve open



No. 47

Student Supplement 1—Valve Data

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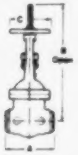
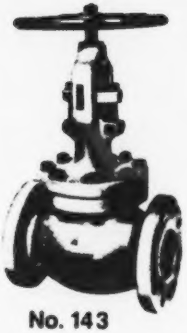
Gate Valve, 2″ to 48″, Class 150
OS&Y Bonnet Bolted, Flexible Wedge Disc
No. 47, Flanged, No. 47 1/2, Butt Welding
Pressure-Temperature Rating Carbon Steel, ASTM A216 Grade WCB
285 psi -20F to 100F

Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches			
	47	47½	A		B	C
			47	47½		
2	46	45	7.0	8.50	15.75	8.0
2½	70	60	7.5	9.50	16.50	8.0
3	76	62	8.0	11.12	18.88	9.0
4	110	95	9.0	12.00	23.00	10.0
5	155	140	10.0	15.00	27.88	12.0
6	175	165	10.5	15.88	31.00	12.0
8	310	260	11.5	16.50	38.75	14.0
10	455	410	13.0	18.00	46.75	16.0
12	650	580	14.0	19.75	55.00	18.0
14	860	730	15.0	22.50	60.50	20.0
16	1120	960	16.0	24.00	66.75	20.0
18	1400	1250	17.0	26.00	76.50	24.0
20	2125	1855	18.0	28.00	89.00	30.0
24	3120	2500	20.0	32.00	104.00	36.0
*30	4520	4150	24.0	36.00	129.50	37.75
*36	6860	6800	28.0	40.00	143.50	—
*42	—	—	31.0	43.00	168.70	—
*48	—	—	34.0	46.00	190.75	—

*Equipped with solid wedge disc.



No. 143

Student Supplement 1—Valve Data

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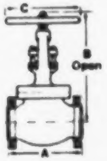
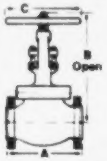
Globe Valves, 2″ to 14″, Class 150
OS&Y Bonnet Bolted, No. 143, Flanged, No. 143 1/2, Butt Welding
Globe Valves, 2″ to 12″, Class 300
OS&Y Bonnet Bolted, No. 151, Flanged, No. 151 1/2, Butt Welding



Weights and Dimensions



Valve Size	Weight—Pounds		Dimensions—Inches		
			A	B	
	143	143½	143 & 143½	143 & 143½	C
2	47	43	8.0	15.00	8.0
2½	66	60	8.5	17.12	10.0
3	82	73	9.5	18.50	10.0
4	134	112	11.5	21.00	12.0
5	199	165	14.0	23.00	12.0
6	240	195	16.0	25.50	14.0
8	370	330	19.5	30.00	16.0
10	525	480	24.5	34.00	20.0
12	900	820	27.5	39.50	24.0
14	1000	880	31.0	41.38	24.0

Valve Size	Weight—Pounds		Dimensions—Inches		
			A	B	
	151	151½	151 & 151½	151 & 151½	C
2	60	48	10.50	16.75	8.0
2½	88	73	11.50	19.00	10.0
3	117	97	12.50	21.00	10.0
4	176	140	14.00	24.00	12.0
5	290	240	15.75	27.50	12.0
6	340	280	17.50	31.00	16.0
8	530	460	22.00	34.25	20.0
10	750	620	24.50	36.00	20.0
12	1100	900	28.00	37.25	24.0

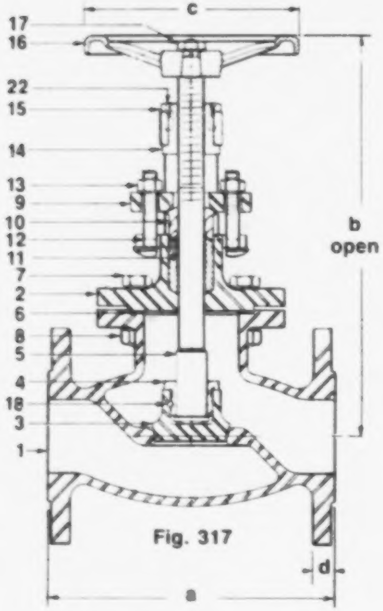
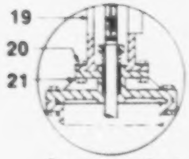
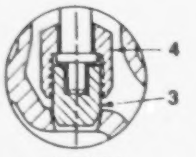


Fig. 317



Separate Yoke Detail
Sizes 8" and 10"



Disc Detail
Sizes ½" to 2"

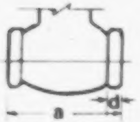


Fig. 310 & Fig. 314

Student Supplement 1—Valve Data

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Stainless Steel Globe Valves, Class 150, OS&Y Bonnet Bolted
No. 310 (1/2″ to 2″), No. 314 (1/2″ to 2″), No. 317 (1/2″ to 10″)

PARTS AND MATERIAL LIST:

DESCRIPTION	MATERIAL	DESCRIPTION	MATERIAL
1 body*	A351 GR CF8M	12 gland bolt	A193 GR B8
2 bonnet	A351 GR CF8M	13 gland bolt nut	A194 GR 8F
3 disc	A351 GR CF8M/ A276 T 316	14 yoke bushing	A582 T 303
4 swivel nut	A351 GR CF8M/ A276 T 316	15 yoke bushing nut	A582 T 303
5 stem	A276 T 316	16 handwheel	malleable iron
6 gasket	PTFE	17 handwheel nut	type 303
7 bonnet bolt	A193 GR B8	18 swivel nut pin	type 316
8 bonnet bolt nut	A194 GR 8F	19 yoke	A351 GR CF8/CF8M
9 gland plate	A351 GR CF8M	20 yoke bolt	A193 GR B8
10 gland follower	A351 GR CF8M/ A276 T 316	21 yoke bolt nut	A194 GR 8F
11 packing	PTFE	22 yoke nut pin	type 303
		23 gland stud**	A193 GR B8
		24 gland stud nut**	A194 GR 8F

DIMENSIONS IN INCHES:

SIZE INCH	½	¾	1	1½	2	3	4	6	8	10
a(310, 314)	3 3/8	3¾	4¼	5½	6½					
a(317)	4¼	4 5/8	5	6½	8	9½	11½	16	19½	24½
b(310, 314)	6½	8	8 3/8	10¼	12					
b(317)	6½	8	8 3/8	10¼	12	14½	17	21 3/8	26	32 3/8
c	3	3½	3½	5	6	8	10	12	16	18
d(314) Depth of Socket	3/8	½	½	½	5/8					
d(317) Flange Thickness	7/16	7/16	7/16	9/16	5/8	¾	15/16	1	1 1/8	1 3/16

WEIGHTS IN POUNDS:

	½	¾	1	1½	2	3	4	6	8	10
310, 314	4.5	6	7	15	23					
317	6.5	8	10	19	31	58	95	173	284	416

Student Supplement 1—Valve Data

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Stainless Steel Gate Valves, 2 1/2" to 12", Class 150
OS&Y Bonnet Bolted, No. 127 Flanged

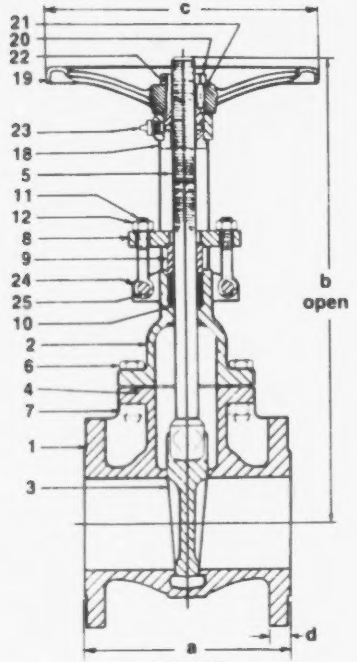
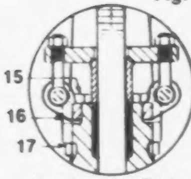
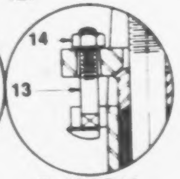


Fig. 127



Bonnet and Yoke Detail
Sizes 8" to 12" incl



Gland Bolt Detail
Sizes 2½" to 3" incl

PARTS AND MATERIAL LIST:

DESCRIPTION	MATERIAL	DESCRIPTION	MATERIAL
1 body*	A351 GR CF8M	15 yoke bolt	A193 GR B8
2 bonnet	A351 GR CF8M	16 yoke	A351 GR CF8M/CF8
3 wedge	A351 GR CF8M	17 yoke bolt	A194 GR 8F
4 gasket	PTFE	18 yoke bushing	A582 T 303 or A743 GR CF16F
5 stem	A276 T 316		
6 bonnet bolt	A193 GB 8	19 handwheel	malleable iron
7 bonnet bolt nut	A194 GR 8F	20 yoke bushing nut	A582 T 303/ A743 GR CF16F
8 gland plate	A351 GR CF8M		
9 gland follower	A276 T 316 or A351 GR CF8M	21 handwheel key	steel
		22 yoke nut set screw	type 303
10 packing	PTFE	23 grease fitting	steel
11 gland eyebolt	A193 GR B8	24 hinge bolt nut	A194 GR 8F
12 gland eyebolt nut	A194 GR 8F	25 hinge bolt	A193 GR B8
13 gland bolt	A193 GR B8	26 yoke nut pin**	type 303
14 gland bolt nut	A194 GR 8F	27 handwheel nut**	A194 GR 8F

DIMENSIONS IN INCHES:

SIZE	INCH	2½	3	4	6	8	10	12
a(127)		7½	8	9	10½	11½	13	14
b		15¾	17⅜	22¼	29¾	42	49⅞	59¼
c		7	7½	10	12	14	16	18
d(127)		$^{11}/_{16}$	¾	$^{15}/_{16}$	1	1⅛	$1^{3}/_{16}$	1¼

WEIGHTS IN POUNDS:

127	42	50	96	150	276	454	655

APPLICABLE CLASS 150 STANDARDS:

End Flanges, ANSI B16.5
Face-to-Face, ANSI B16.10
Wall Section, ANSI B16.34
Pressure-Temperature Ratings, ANSI B16.34

Student Supplement 1—Valve Data

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Stainless Steel Swings Check Valves, Class 150
No. 370 (1/2″ to 2″), Threaded Ends, No. 374 (1/2″ to 2″), Socket Welded Ends
No. 377 (1/2″ to 12″), Flanged Ends, 377-FF, Flat Faced Flanged Ends

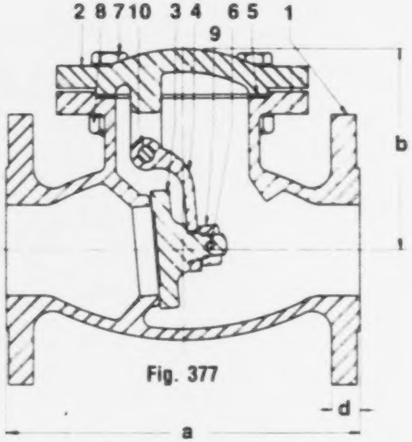


Fig. 377

PARTS AND MATERIAL LIST:

DESCRIPTION	MATERIAL
1 body††	A351 GR CF8M
2 cover	A351 GR CF8M
3 disc	A351 GR CF8M/A276 T 316
4 clapper arm	A351 GR CF8M
5 gasket	PTFE
6 disc nut pin**	A276 T 316
7 cover bolt	A193 GR B8
8 cover bolt nut	A194 GR 8F
9 disc nut	A194 GR 8M
10 clapper arm shaft	A276 T 316
11 disc nut washer†	A276 T 316

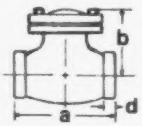


Fig. 370
Fig. 374

DIMENSIONS IN INCHES:

SIZE INCH	½	¾	1	1½	2	2½	3	4	6	8	10	12
a(370, 374)	3¾	3¾	5	6	6½							
a(377)	4¼	4⅝	5	6½	8	8½	9½	11½	14	19½	24½	27½
b(370, 374)	2¾	3	3⅜	4	4½							
b(377)	2¾	3	3⅜	4	4½	5¼	5⅝	6¾	8	10	13⅛	14⅞
d(374) Depth of Socket	⅜	½	½	½	⅝							
d(377)	7/16	7/16	7/16	9/16	⅝	11/16	¾	15/16	1	1⅛	1³/16	1¼

WEIGHTS IN POUNDS:

	½	¾	1	1½	2	2½	3	4	6	8	10	12
370, 374	4.5	4.5	7	11.5	16.5							
377	5	6	10	17	26	37	52	76	145	260	380	435

Valves
Unit 4

Student Supplement 2—Typical Bolted Bonnet Gate Valve

General Information: The following information and accompanying pictorial are copyrighted ©by Crane Valves, and reprinted with permission. The Crane gate valve presented here was presented because of the many facets of valve design/structure it demonstrates. There is no intention to endorse a particular company or product. These Crane gate valves offer dependable service for steam, air, gas, oil, oil vapor, and high pressure installation. All have straight-through ports to assure minimum turbulence, erosion, and resistance to flow. They are available in a wide variety of stems. Place the illustration on the following page alongside as you read the following descriptions of important elements of valve design/structure.

1. **Body:** is cast to provide liberal strength to meet operating conditions and to permit unobstructed flow. Turbulence, erosion, and pressure drop are minimized.

   Flanged End: is illustrated here. Crane cast steel gate valves are also available with butt welding ends. All flanged and butt welding end valves are designed to conform to ANSI B16.5 and ANSI B16.34 standards.

2. **Integral Yoke & Bonnet** is shown. Some designs incorporate a two-piece bonnet and yoke. all bonnet assemblies are cast and finished to the same exacting tolerances as the bodies for accurate alignment of stems and ease of sealing. Bonnet joint varies from flat face gasket-joint (shown) to ring-type bonnet joint, depending on Class.

3. **Seat Rings** (not illustrated) are seal welded to eliminate leak path behind rings and for long trouble-free service. The surfaces are precision ground to fit accurately with the disc. Seats are regularly furnished hard faced. All others are optional.

4. **Disc:** Crane's one-piece flexible disc is shown. The merits of this design are attested to by its many imitations. Basically, it provides accurate alignment of mating seating surfaces so the valve can absorb piping strains without leakage. Also, it avoids any tendency to stick in the seated position. Valves are also furnished with solid wedge discs that have proved successful in millions of applications.

5. **Stem:** The tee-head disc-stem connection prevents lateral strain on the stem for smooth, easy operation. Accurately cut threads engage the yoke sleeve for positive control of disc position.

6. **Yoke Sleeve**

7. **Handwheel Nut**

8. **Yoke Sleeve Retaining Nut**

9. **Packing:** contains corrosion inhibitor to avoid stem pitting. Stuffing box is deep, assuring long packing life.

Student Supplement 2

10. **Gland:** is a two-piece ball-type which exerts even pressure on the packing without binding the stem.

11. **Gland Flange**

12. **Gland Eye Bolts:** swing aside for ease in repacking the stuffing box.

13. **Gland Eye Bold Nuts**

14. **Bonnet Gasket:** seals joint from possible leakage.

15. **Bonnet Studs**
16. **Bonnet Nuts** number is dependent on valve size and class.

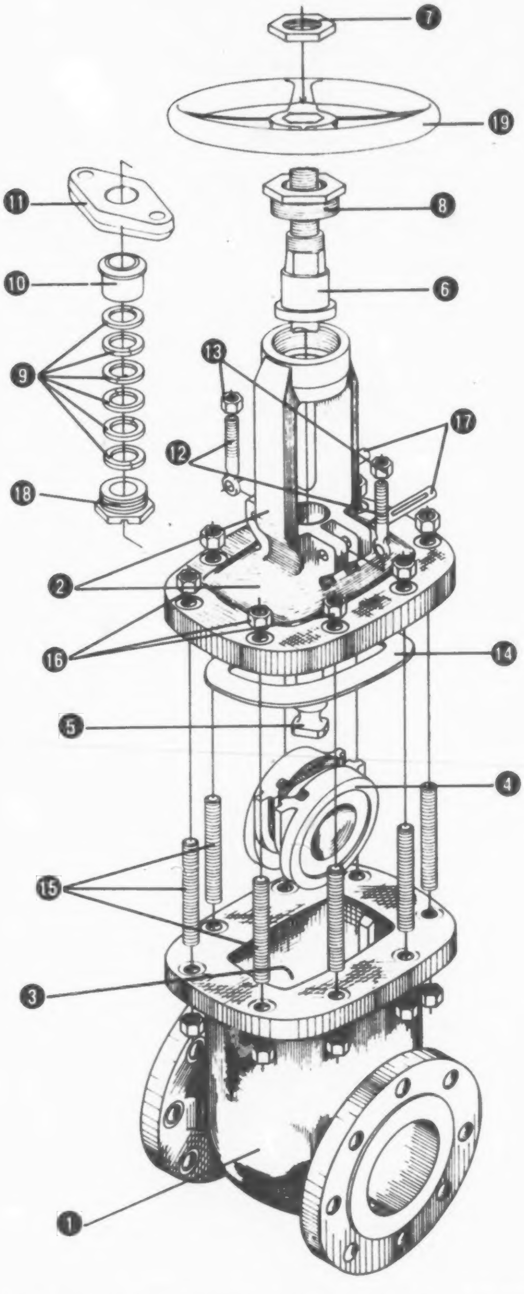
Hydraulic Grease Fitting: provides for lubrication of yoke sleeve bearing surfaces.

17. **Groove-Pin**

18. **Bonnet Bushing**

19. **Handwheel:** Crane gate valves can also be supplied with gear or motor operators.

Student Supplement 2


7
19
11
8
10
6
9
13
17
12
18
2
16
14
5
4
15
3
1

This illustration represents a typical Crane gate valve. It is not intended to show all the details and construction of all Crane gate valves.

Valves
Unit 4

Assignment Sheet 1—Determine Check Valve Data

Student Name ______________________________ Overall Rating __________

Evaluation criterion	**Rating**
Number of correct responses out of 20	______

Directions: Reference Student Supplement 1 as needed to complete the following data.

1. The F to F dimension of a;
   - a. 6″ 300# flanged swing check valve ______
   - b. 8″ 300# flanged swing check valve ______
   - c. 4″ 300# welded swing check valve ______
   - d. 18″ 300# welded swing check valve ______
2. The weight of a;
   - a. 1″ 150# flanged swing check valve ______
   - b. 5″ 300# flanged swing check valve ______
   - c. 12″ 150# welded swing check valve ______
   - d. 20″ 300# welded swing check valve ______
3. The F to F dimension of a;
   - a. 16″ 150# flanged tilting disc check valve ______
   - b. 30″ 300# flanged tilting disc check valve ______
   - c. 14″ 300# welded tilting disc check valve ______
   - d. 18″ 150# welded tilting disc check valve ______
4. The weight of a;
   - a. 12″ 150# flanged tilting disc check valve ______
   - b. 2″ 300# flanged tilting disc check valve ______
   - c. 36″ 300# welded tilting disc check valve ______
   - d. 8″ 150# welded tilting disc check valve ______

Assignment Sheet 1

5. The F to F dimension of a;

   a. 2″ 125# threaded lift check valve ______
   b. 6″ 300# flanged straight way stop check valve ______
   c. 1″ 300# lift check valves ______
   d. 8″ 300# straight way stop check valve ______

Valves
Unit 4

Assignment Sheet 2—Determine Gate Valve Data

Student Name ______________________ Overall Rating __________

Evaluation criterion	**Rating**
Number of correct responses out of 20	______

Directions: Reference Student Supplement 1 as needed to complete the following data.

1. The F to F dimension of a;
   a. 1″ 150# flanged gate valve ______
   b. 2″ 150# flanged gate valve ______
   c. 2½″ 150# flanged gate valve ______
   d. 3″ 150# flanged gate valve ______

2. The overall stem height of a;
   a. 1¼″ 150# flanged gate valve ______
   b. 1½″ 150# flanged gate valve ______
   c. 2½″ 150# flanged gate valve ______
   d. 3″ 150# flanged gate valve ______

3. The F to F dimension of a;
   a. 8″ 150# flanged gate valve ______
   b. 3″ 150# flanged gate valve ______
   c. 4″ 150# welded gate valve ______
   d. 10″ 150# welded gate valve ______

4. The weight of a;
   a. 16″ 150# flanged gate valve ______
   b. 30″ 150# flanged gate valve ______
   c. 14″ 150# welded gate valve ______
   d. 18″ 150# welded gate valve ______

Assignment Sheet 2

5. The overall stem height of a;

   a. 6″ 150# flanged gate valve ________
   b. 12″ 150# flanged gate valve ________
   c. 20″ 150# welded gate valve ________
   d. 36″ 150# welded gate valve ________

Valves
Unit 4

Assignment Sheet 3—Determine Stainless Steel Valve Data

Student Name ______________________________ Overall Rating __________

Evaluation criterion	**Rating**
Number of correct responses out of 28	______

Directions: Reference Student Supplement 1 as needed to complete the following data.

1. The F to F dimension of a;
   - a. 8″ 150# flanged gate valve ______
   - b. 12″ 150# flanged swing check valve ______
   - c. 6″ 150# flanged globe valve ______
   - d. 2″ 150# socket weld globe valve ______
   - e. 1″ 150# socket weld globe valve ______
   - f. 2″ 150# threaded globe valve ______
   - g. 10″ 150# flanged gate valve ______
   - h. 3″ 150# flanged gate valve ______
2. The overall stem height of a;
   - a. 8″ 150# flanged gate valve ______
   - b. 12″ 150# flanged swing check valve ______
   - c. 6″ 150# flanged globe valve ______
   - d. 2″ 150# socket weld globe valve ______
   - e. 1″ 150# socket weld globe valve ______
   - f. 2″ 150# threaded globe valve ______
   - g. 10″ 150# flanged gate valve ______
   - h. 3″ 150# flanged gate valve ______
3. The weight of a;
   - a. 8″ 150# flanged gate valve ______
   - b. 12″ 150# flanged swing check valve ______
   - c. 6″ 150# flanged globe valve ______
   - d. 2″ 150# socket weld globe valve ______
   - e. 1″ 150# socket weld globe valve ______
   - f. 2″ 150# threaded globe valve ______
   - g. 10″ 150# flanged gate valve ______
   - h. 3″ 150# flanged gate valve ______

Assignment Sheet 3

4. The centerline to tope of valve distance of a;

   a. 6″ 150# flanged swing check valve ______
   b. 12″ 150# flanged swing check valve ______
   c. ¾″ 150# socket weld swing check valve ______
   e. 2″ 150# threaded swing check valve ______

Piping Plans and Elevations
Unit 5

Objective Sheet

Unit Objective

After completing this unit, the student should be able to draw a piping plan view, a piping section view, and a piping plan and elevations. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to piping plans and elevations with their definitions.
2. Select dimensions for plan and elevation coordinate systems.
3. Complete a chart of abbreviations used on piping plans and elevations.
4. Match pipe hangers with their correct uses.
5. Match pipe supports with their correct uses.
6. Select true statements about concrete foundations.
7. Complete statements about pipe racks.
8. Complete statements about guidelines for placing pipe on a rack.
9. Match methods of providing piping flexibility with their applications.
10. Match types of insulation with their applications.
11. Define abbreviations for types of insulation.
12. Draw a piping plan. (Assignment Sheet 1)
13. Draw a piping section view. (Assignment Sheet 2)
14. Draw a piping plan and elevation. (Assignment Sheet 3)

Piping Plans and Elevations
Unit 5

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Make transparencies from transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Heat Exchanger Plan and Elevation (Objective 2)
   TM 2—Typical Platform Elevation (Objective 2)
   TM 3—Plot Plan (Objective 2)
   TM 4—Equipment Layout Sheet (Objective 2)

5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.
10. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Suggested Activities

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment sheets.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Read the assignment sheets carefully. Impress students with the fact that this entire unit is designed to help them draw a piping plan and elevation. Skill areas: **Learning skills, learning to learn.**

2. Use TMs 1 through 4 to best advantage by correlating them with objectives in the Information Sheet. Try to have other drawings available to show the variety of applications piping plans can serve. Skill areas: **Basic skills, listening.**

3. Select teams and appoint team leaders to complete the assignment sheets. Encourage the teams to complete the assignment at a CAD station because students will probably have many errors on the first run through. Use the occasion to point out how fast and easy and clean it is to make corrections with CAD. Skill areas: **Group effectiveness skills, teamwork.**

Resources Used in Developing This Unit

1. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

2. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division/McGraw-Hill Book Co., 1981.

3. Weaver, Rip. *Process Pipe Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Activities

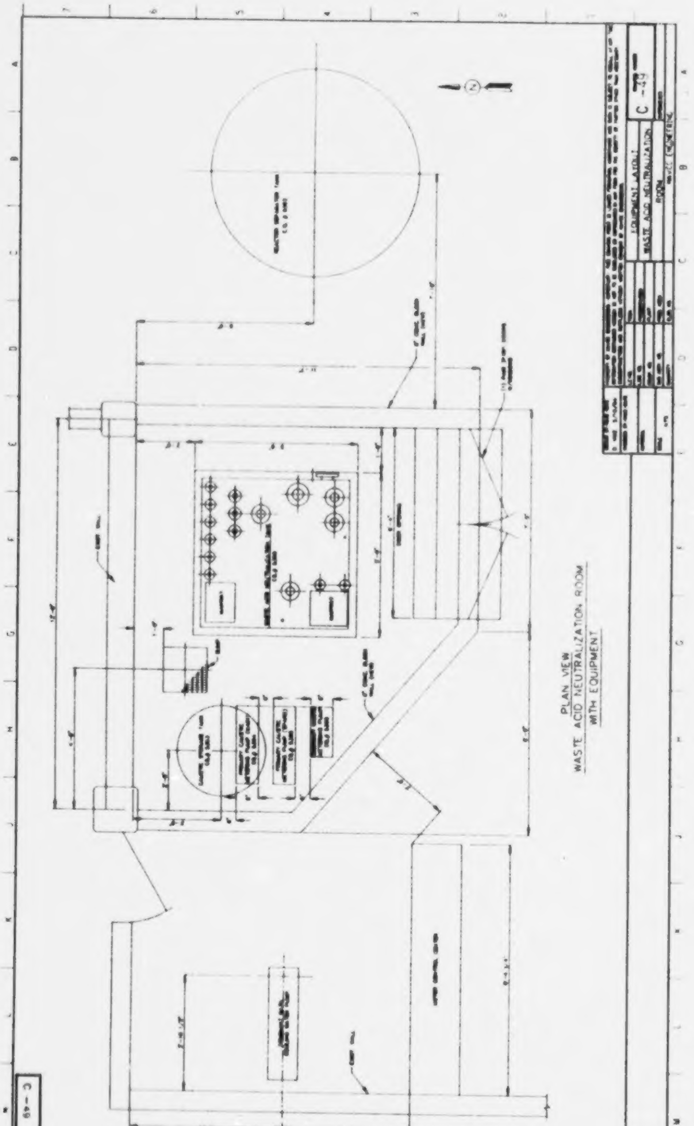
Suggested Supplemental Resources

To help first-time CAD students learn the ins and outs of DOS and managing the file systems needed for CAD, order *The CAD Survival Kit.* It is the first of MAVCC's CAD series, and available from the Mid-America Vocational Curriculum Consortium. For information, call toll free: 1-800-654-3988.

Piping Plans and Elevations
Unit 5

Answers to Assignment Sheets

Assignment Sheet 1


PLAN VIEW
WASTE ACID NEUTRALIZATION ROOM
WITH EQUIPMENT
EQUIPMENT LAYOUT
WASTE ACID NEUTRALIZATION ROOM
C-49

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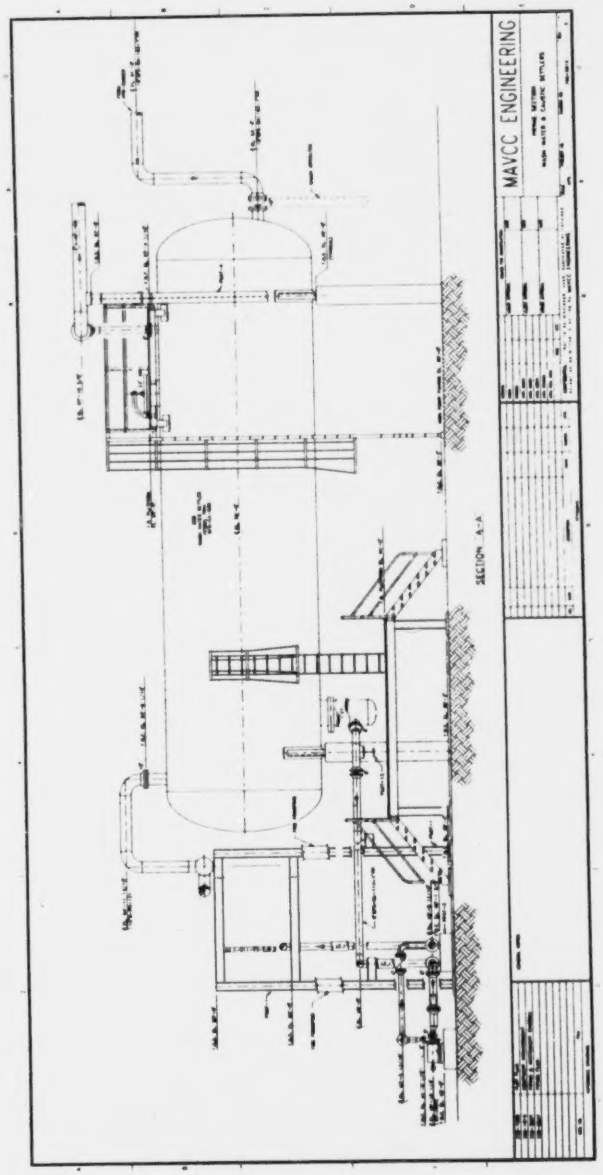
Answers to Assignment Sheets

Assignment Sheet 2


MAVCC ENGINEERING
SECTION A-A

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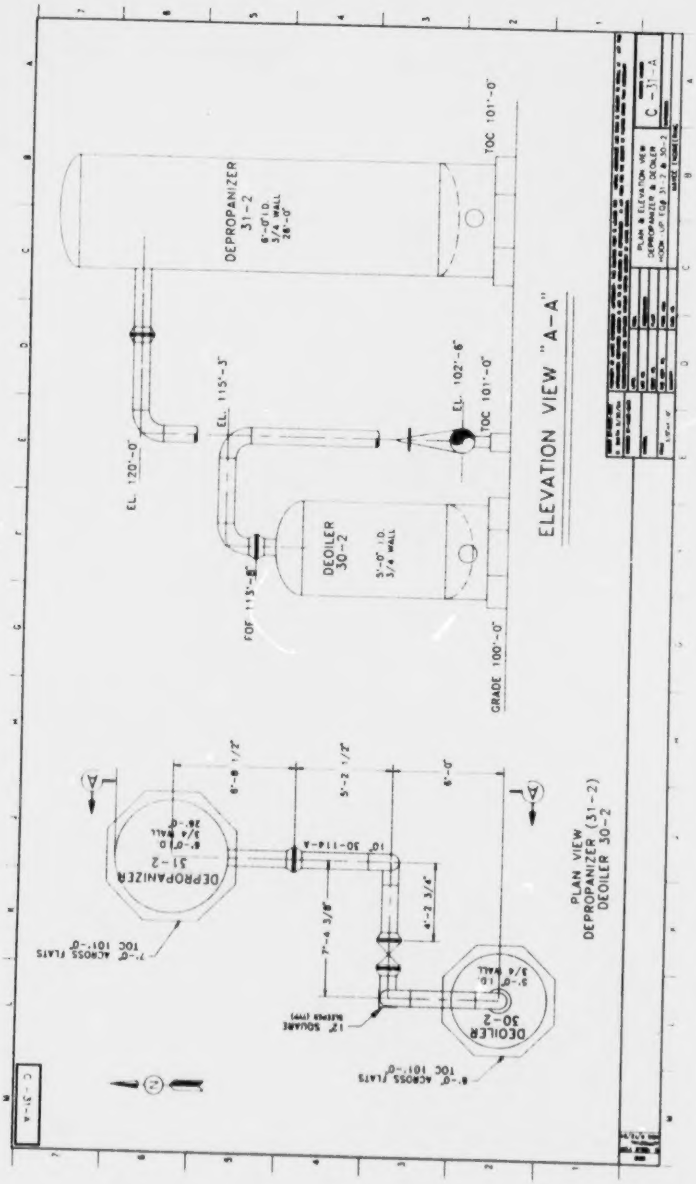
Answers to Assignment Sheets

Assignment Sheet 3


DEPROPANIZER
31-2
6'-0" I.D.
3/4 WALL
26'-0"
TOC 101'-0"
EL. 120'-0"
EL. 115'-3"
EL. 102'-6"
TOC 101'-0"
DEOILER
30-2
5'-0" I.D.
3/4 WALL
FOF 113'-8"
GRADE 100'-0"
ELEVATION VIEW "A-A"
6'-8 1/2"
5'-2 1/2"
6'-0"
10" 30-114-A
4'-2 3/4"
7'-4 3/8"
7'-0" ACROSS FLATS
TOC 101'-0"
12" SQUARE SLEEPER (TYP)
8'-0" ACROSS FLATS
TOC 101'-0"
PLAN VIEW
DEPROPANIZER (31-2)
DEOILER 30-2
A
A
N
C-31-A
PLAN & ELEVATION VIEW
DEPROPANIZER & DEOILER

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Piping Plans and Elevations
Unit 5

Answers to Written Test

1.
   - a. 5
   - b. 10
   - c. 7
   - d. 1
   - e. 9
   - f. 6
   - g. 3
   - h. 8
   - i. 4
   - j. 2

2.
   - a. (2), (4)
   - b. (2), (3)
   - c. (4)
   - d. (4)

3.

CO	Clean out	TOC	Top of concrete
GR	Grade	SWG	Swage
GU	Guide	PS	Pipe support
INS	Insulate	EL or ELEV	Elevation
HDR	Header	BD	Blowdown
HGR	Hanger	COND	Condensate
SUCT	Suction	SUPT	Support
BOP	Bottom of pipe	NPS	National pipe size
SMLS	Seamless	SPEC	Specification
B/M	Bill of material	NS	Near side

4.
   - a. 4
   - b. 5
   - c. 2
   - d. 1
   - e. 3

5.
   - a. 3
   - b. 5
   - c. 2
   - d. 1
   - e. 4

6. a, c, d, g

7.
   - a. I beams
   - b. Stanchions
   - c. Structural stability
   - d. Elevated
   - e. Parallel

Answers to Written Test

8.
   a. Outer edges
   b. Top
   c. Over the top of
   d. Shorter
   e. Outside
   f. Shoes
   g. Pipe rack
   h. 90°

9.
   a. 1
   b. 3
   c. 2

10.
   a. 2
   b. 4
   c. 5
   d. 1
   e. 3

11.
   a. Steam trace
   b. Hot personal
   c. Hot freeze protection
   d. Cold
   e. Hot
   f. Heat trace

Piping Plans and Elevations
Unit 5

Written Test

Name ________________________ Date ________________ Score ______

1. Match the terms on the right with the correct definitions.

_______a. All mechanisms which enable the piping system to be maintained by allowing for various types of mechanical, thermal, or shock movement and physical weight of the system

_______b. A method of dimensioning which uses a grid and N/S or E/W dimensions from a benchmark

_______c. Small, low-elevation concrete pier, usually rectangular in shape, used to support pipe close to the grade; is sometimes referred to as a sleeper

_______d. Any device that allows the piping to be hung from above

_______e. Any device that allows the piping to be supported from below

_______f. Relating to vibration caused by an earthquake

_______g. Any expansion or contraction of the piping system due to a change in temperature associated with the pipe material

_______h. Horizontal components of pipe racks, usually made of structural steel

_______i. Structure consisting of stanchions and struts; usually freestanding and used to support pipe

_______j. Vertical components of pipe racks, usually pipe or structural steel

1. Pipe hanger
2. Stanchions
3. Thermal movement
4. Pipe rack
5. Pipe support group
6. Seismic
7. Pipe pier
8. Struts
9. Pipe support
10. Coordinate system

Written Test

2. Select dimensions for plan and elevation coordinates. Place an "X" in the blank or blanks that properly describe the coordinates.

a. S.2 + 13 – 8

_______(1) North of the benchmark
_______(2) South of the benchmark
_______(3) 2138′ from the benchmark
_______(4) 213′-8″ from the benchmark
_______(5) 213.8′ from the benchmark

b. W.6 + 45 – 3.5

_______(1) East of the benchmark
_______(2) West of the benchmark
_______(3) 645′-3.5″ from the benchmark
_______(4) 6450′-3.5″ from the benchmark
_______(5) 6 miles 450′-3.5″ from the benchmark

c. ℄ EL 102′-6″

_______(1) East of the benchmark
_______(2) North of the benchmark
_______(3) 2′-6″ Below grade
_______(4) 102′-6″ Above grade
_______(5) 2′-6″ Above grade

d. ℄ EL 107′-11″

_______(1) East of the benchmark
_______(2) North of the benchmark
_______(3) 7′-11″ Below grade
_______(4) 107′-11″ Above grade
_______(5) 7′-11″ Above grade

Written Test

3. Complete the following chart of abbreviations used on piping plans and elevations. Insert the meaning of the abbreviation or the abbreviation itself as indicated.

CO	____________	TOC	____________
GR	____________	SWG	____________
________	Guide	________	Pipe support
INS	____________	________	Elevation
________	Header	________	Blowdown
________	Hanger	COND	____________
________	Suction	SUPT	____________
BOP	____________	NPS	____________
________	Seamless	________	Specification
B/M	____________	________	Near side

4. Match common pipe hangers with their correct uses. Place the number beside the hanger type in the blank beside its description.

______a. Used for noncritical pipe installations

______b. Used for free movement of the pipe in horizontal directions within specified limits

______c. Used in combination with other pipe support devices for movement caused by thermal and seismic disturbances

______d. Used for free horizontal movement parallel to the pipe

______e. Used for rigid pipe placement

1. Roller
2. Spring
3. Anchor
4. Pipe clamp
5. Rod

Written Test

5. Match pipe supports with their correct uses. Place the number beside the support type in the blank beside its description.

_______a. Used for supporting insulated pipes on pipe racks or pipe supports

_______b. Used for free horizontal movement along the length of the pipe for noninsulated or insulated lines

_______c. Used for movement of pipe in only one direction

_______d. Used on insulated pipes to prevent pipe from crushing insulation

_______e. Pieces of pipe welded onto pipe used to support the line

1. Shoe
2. Guide
3. Saddle
4. Dummy supports
5. Roller

6. Select true statements concerning concrete foundations. Place an "X" beside each true statement.

_______a. Foundations for stanchions or structural steel that have base plates are 1′-0″ above grade.

_______b. Steel pipe stanchions with embedded foundations are a minimum of 1′-0″ above paved areas and 10′-0″ above grade in unpaved areas.

_______c. Dummy support base is placed flat on concrete in paved areas and 6″ above grade in unpaved areas, usually on a sleeper.

_______d. Concrete stanchions with embedded foundations are placed with top of foundation 1′-0″ above grade in unpaved areas.

_______e. For vessels or columns with skirts or legs, foundations are placed 1″ above grade.

_______f. Pump foundations are placed 5′0-″ above concrete paving or grade.

_______g. Horizontal vessel foundations are placed from 1′-0″ to 4′-0″ above grade.

_______h. Pipe pier foundations are placed from 5″ to 6″ above grade.

Written Test

7. Complete statements about pipe racks. Circle the material that best completes each of the following statements.

   a. Racks consist of steel channel, (**I beams**) (**T beams**), pipe, or precast concrete members.

   b. (**Stabilizers**) (**Stanchions**) consist of structural steel, pipe, or precast concrete vertical members.

   c. Struts are used for (**structural stability**) (**extra ladders**) between pipe racks.

   d. (**Elevated**) (**Underground**) pipe racks are used to permit access around equipment and process areas.

   e. Pipe racks are used for multiple, (**perpendicular**) (**parallel**) pipe runs and for spanning great distance pipe runs.

8. Complete statements about guidelines for placing pipe on pipe racks. Circle the material that best completes each of the following statements.

   a. Place heavy, large diameter pipe lines on (**inside**) (**outer edges**).

   b. Place process lines on the side nearest the equipment and on the (**bottom**) (**top**) layer of a multiple-level pipe racks.

   c. Place piping loops for expansion (**over the top of**) (**underneath**) the pipe rack; for multiple-level pipe racks, allow clearance for loops between levels of the pipe rack.

   d. Support small diameter pipes of (**longer**) (**shorter**) span distances with shoes or bracing.

   e. Arrange instrument lines and conduit lines on the (**inside**) (**outside**) of the pipe racks to allow quick access for maintenance and reworking.

   f. Support insulated lines on (**boots**) (**shoes**) and in some cases, slide arrangements to retard breaking of thermal barrier.

   g. Lay noninsulated lines directly on the (**pipe rack**) (**cross member**), if needed.

   h. Extend take-off lines from the pipe rack usually (**45°**) (**90°**) vertical or horizontal from the main line.

Written Test

9. Match methods of providing piping flexibility on the right with their correct applications.

______a. L, C, or U shapes used in piping systems that undergo high temperature and high pressure operations

______b. Used in piping systems to relieve thermal stress

______c. Used in low pressure and/or low temperature operations where vibration is often the largest concern

1. Bends
2. Expansion joints
3. Offsets or change-of-directions

10. Match kinds of insulation materials with their typical applications. Place the number beside the insulation type in the blank beside its application.

______a. Used on hot and cold water lines up to 212°F

______b. Used for low thermal conductivity and high moisture resistance

______c. Rigid, structural insulation used for temperatures up to 600°F

______d. Calcium silicate and asbestos fiber material with aluminum jacket used for steam and process lines for temperatures of 600° to 1200°F

______e. Steam tubing wrapped around a pipe to keep liquids from freezing, to keep viscous liquid from setting up, and to vaporize small amounts of condensate that may form in a vapor system

1. Aluminum-armored
2. Wool felt
3. Steam tracing
4. Rock or vegetable cork
5. Fiberglass

Written Test

11. Define the following abbreviations for types of insulation.

    a. ST ______________________________

    b. HP ______________________________

    c. HF ______________________________

    d. C ______________________________

    e. H ______________________________

    f. HT ______________________________

*Permission to duplicate this test is granted.

Piping Plans and Elevations
Unit 5

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Draw a Piping Plan View Rating ______

Comments: ______________________________________

____

Assignment Sheet 2—Draw a Piping Section View Rating ______

Comments: ______________________________________

____

Assignment Sheet 3—Draw a Piping Plan and Elevation Rating ______

Comments: ______________________________________

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ______________________________________

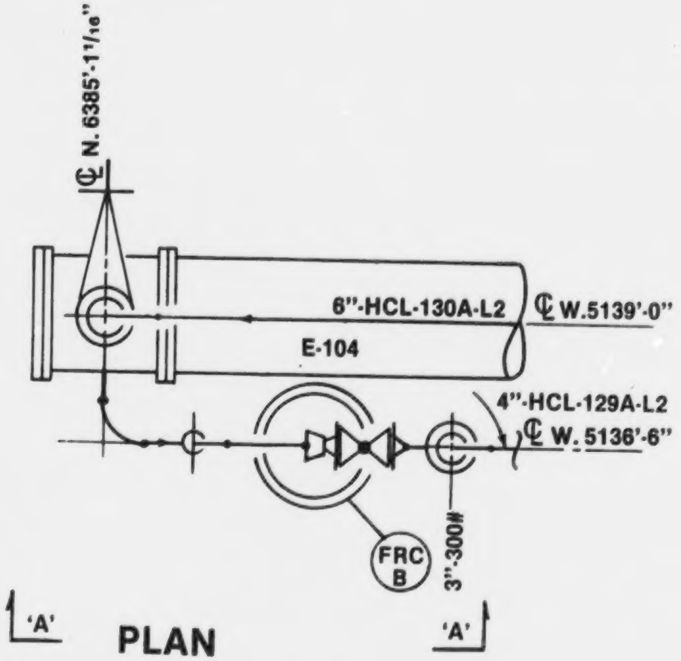
____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

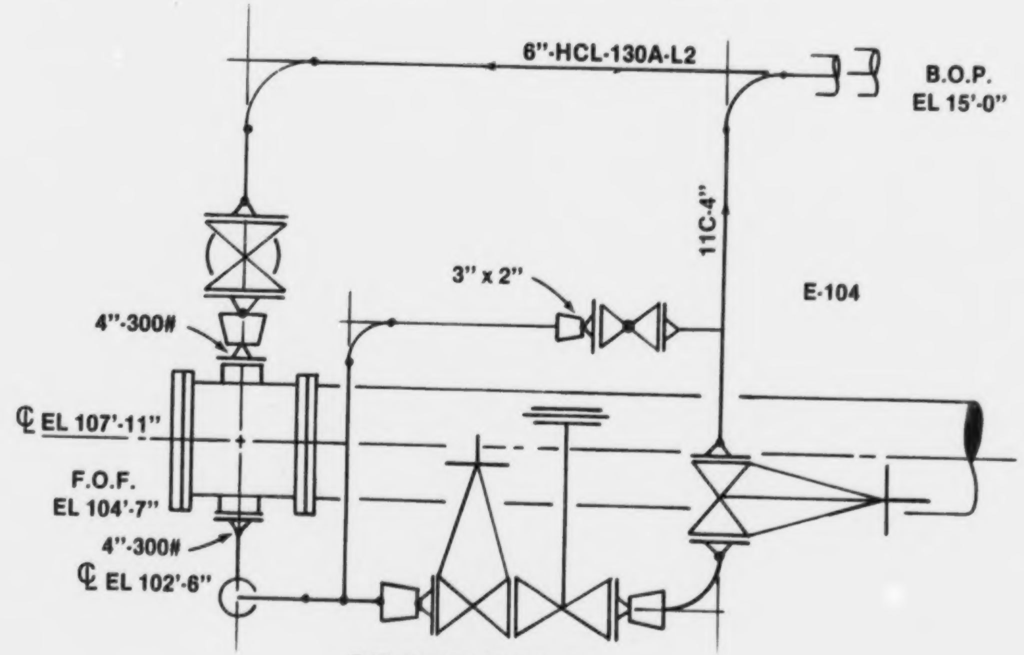
***Permission to duplicate this form is granted.**

Heat Exchanger Plan and Elevation



℄ N. 6385'-1 1/16"
6"-HCL-130A-L2
℄ W.5139'-0"
E-104
4"-HCL-129A-L2
℄ W. 5136'-6"
FRC
B
3"-300#
'A'
'A'

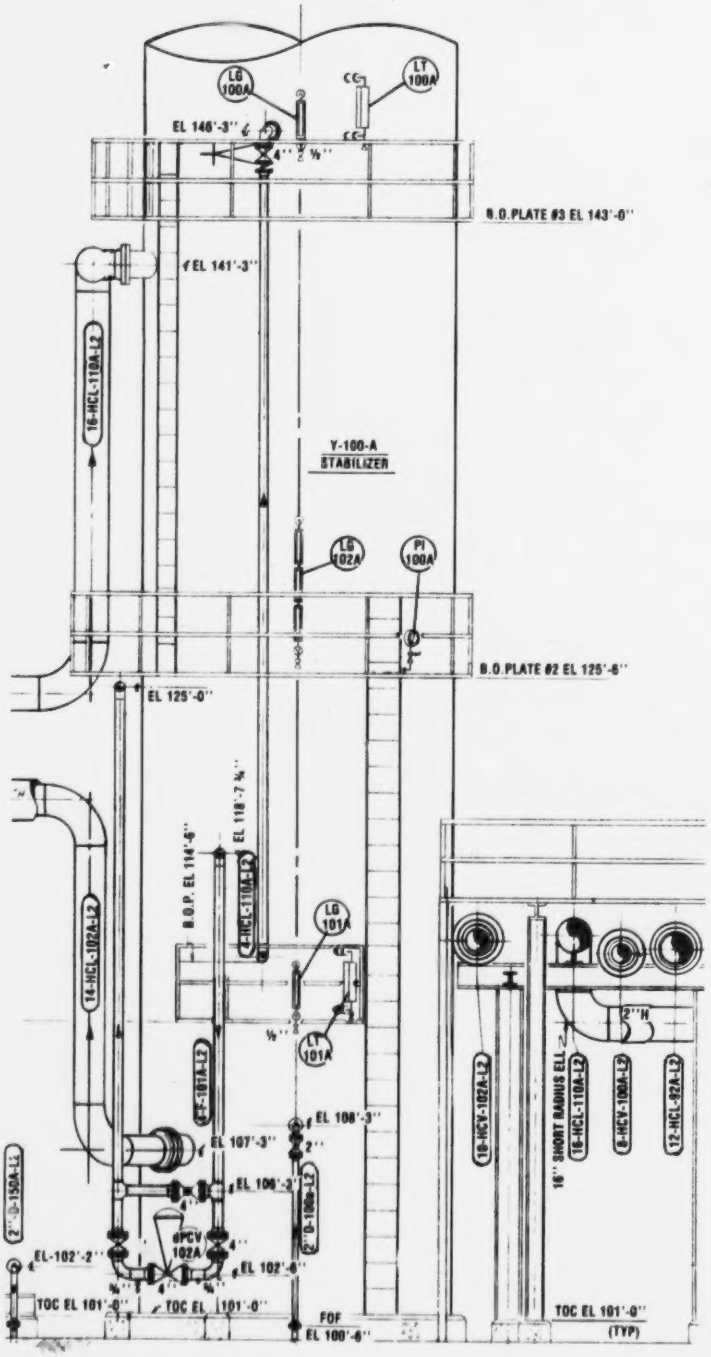
PLAN



6"-HCL-130A-L2
B.O.P.
EL 15'-0"
11C-4"
3" x 2"
E-104
4"-300#
℄ EL 107'-11"
F.O.F.
EL 104'-7"
4"-300#
℄ EL 102'-6"

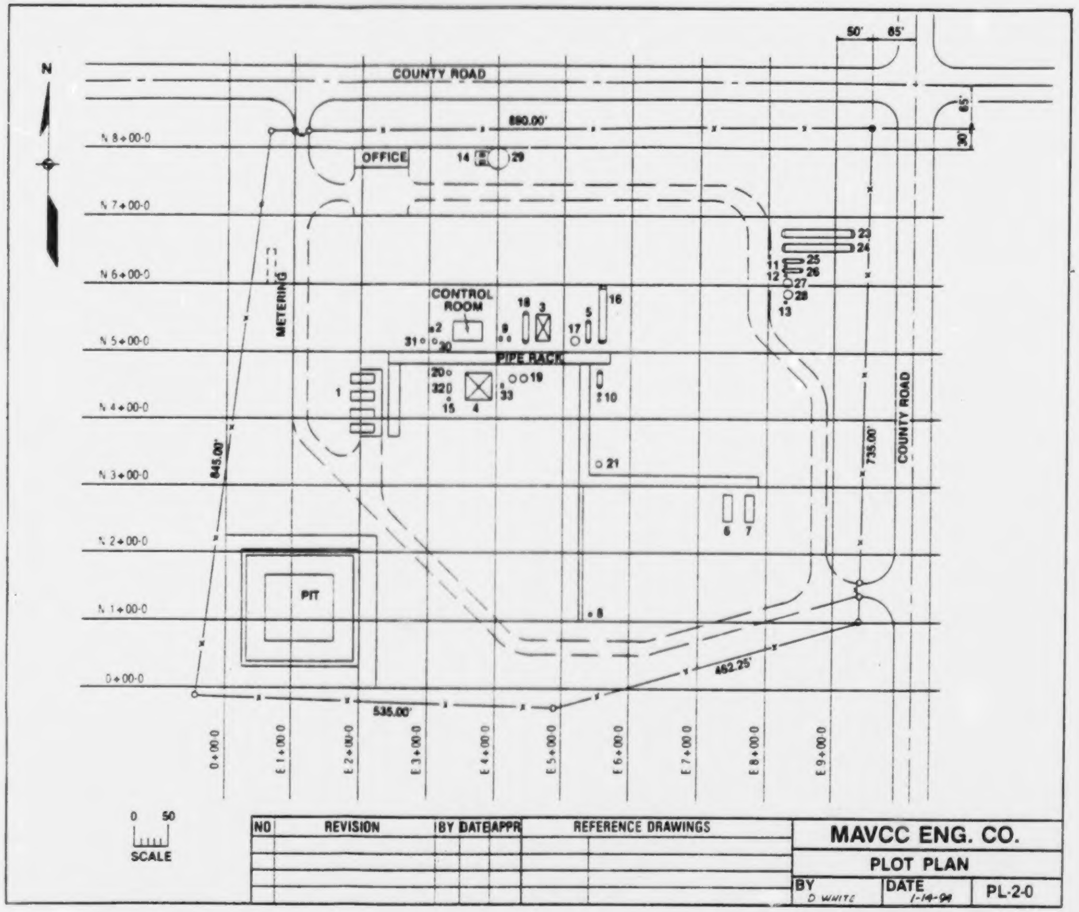
SECTION 'A-A'

Typical Platform Elevation

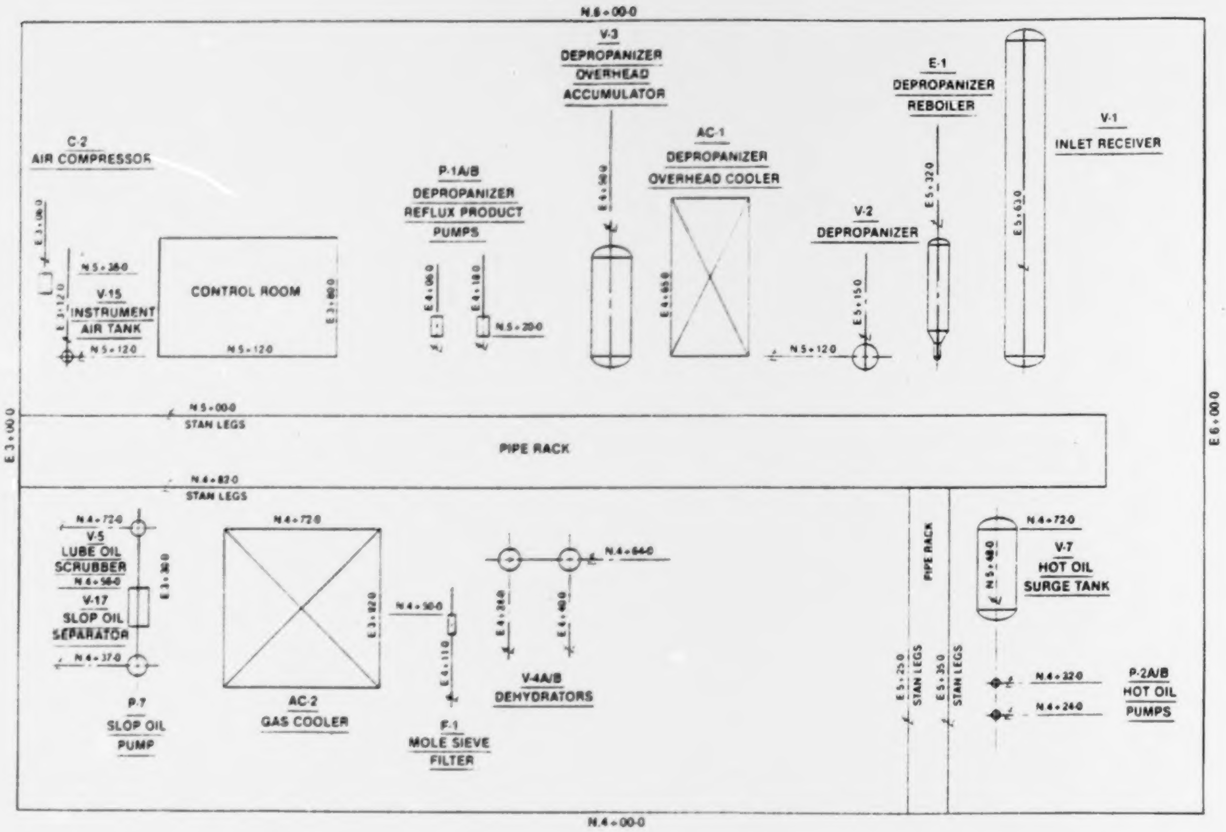

LG 100A
LT 100A
EL 146'-3"
4"
2 ½"
B.O.PLATE #3 EL 143'-0"
EL 141'-3"
16-HCL-110A-L2
Y-100-A
STABILIZER
LG 102A
PI 100A
B.O.PLATE #2 EL 125'-6"
EL 125'-0"
EL 118'-7 ¾"
B.O.P. EL 114'-6"
4-HCL-110A-L2
14-HCL-102A-L2
LG 101A
½"
LT 101A
2-F-101A-L2
EL 108'-3"
2"
EL 107'-3"
EL 106'-3"
4"
dPCV 102A
2"-D-106A-L2
2"-D-150A-L2
EL-102'-2"
EL 102'-6"
¾"
TOC EL 101'-0"
TOC EL 101'-0"
FOF
EL 100'-6"
18-HCV-102A-L2
16" SHORT RADIUS ELL
16-HCL-110A-L2
8-HCV-100A-L2
12-HCL-92A-L2
2"H
TOC EL 101'-0"
(TYP)

Courtesy of Phillips Petroleum Co.

Plot Plan


N
COUNTY ROAD
50'
85'
65'
30'
890.00'
N 8+00-0
N 7+00-0
N 6+00-0
N 5+00-0
N 4+00-0
N 3+00-0
N 2+00-0
N 1+00-0
0+00-0
OFFICE
14
29
23
24
25
26
11
12
27
28
13
METERING
CONTROL ROOM
18
3
16
5
17
9
2
31
30
PIPE RACK
20
32
15
4
33
19
10
1
21
845.00'
735.00'
COUNTY ROAD
6
7
PIT
8
462.25'
535.00'
0+00.0
E 1+00.0
E 2+00.0
E 3+00.0
E 4+00.0
E 5+00.0
E 6+00.0
E 7+00.0
E 8+00.0
E 9+00.0
0
50
SCALE
NO
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
PLOT PLAN
BY
D WHITE
DATE
1-14-94
PL-2-0

Equipment Layout Sheet


N.6 + 00-0
V-3
DEPROPANIZER
OVERHEAD
ACCUMULATOR
E-1
DEPROPANIZER
REBOILER
V-1
INLET RECEIVER
C-2
AIR COMPRESSOR
AC-1
DEPROPANIZER
OVERHEAD COOLER
P-1A/B
DEPROPANIZER
REFLUX PRODUCT
PUMPS
V-2
DEPROPANIZER
E 3 + 08 0
N 5 + 38-0
V-15
INSTRUMENT
AIR TANK
E 3 + 12 0
N 5 + 12 0
CONTROL ROOM
N 5 + 12 0
E 3 + 80 0
E 4 + 06 0
E 4 + 18 0
N 5 + 20-0
E 4 + 50 0
E 4 + 65 0
E 5 + 32 0
E 5 + 15 0
N 5 + 12 0
E 5 + 63 0
E 3 + 00 0
N 5 + 00-0
STAN LEGS
PIPE RACK
N 4 + 82-0
STAN LEGS
E 6 + 00 0
N 4 + 72-0
V-5
LUBE OIL
SCRUBBER
N 4 + 56-0
V-17
SLOP OIL
SEPARATOR
N 4 + 37-0
E 3 + 36 0
P-7
SLOP OIL
PUMP
N 4 + 72 0
E 3 + 82 0
AC-2
GAS COOLER
N 4 + 50-0
E 4 + 11 0
F-1
MOLE SIEVE
FILTER
N.4 + 64-0
E 4 + 28 0
E 4 + 40 0
V-4A/B
DEHYDRATORS
PIPE RACK
E 5 + 25 0
STAN LEGS
E 5 + 35 0
STAN LEGS
N 5 + 48 0
N 4 + 72-0
V-7
HOT OIL
SURGE TANK
N 4 + 32-0
N 4 + 24-0
P-2A/B
HOT OIL
PUMPS
N.4 + 00-0

Piping Plans and Elevations
Unit 5

Information Sheet

1. **Terms and Definitions**

    a. **Coordinate system** — A method of dimensioning which uses a grid and N/S or E/W dimensions from a benchmark

    b. **Pipe hanger** — Any device that allows the piping to be hung from above

    c. **Pipe pier** — Small, low-elevation concrete pier, usually rectangular in shape, used to support pipe close to the grade; is sometimes referred to as a sleeper

    d. **Pipe rack** — Structure consisting of stanchions and struts; usually freestanding and used to support pipe

    e. **Pipe support** — Any device that allows the piping to be supported from below

    f. **Pipe support group** — All mechanisms which enable the piping system to be maintained by allowing for various types of mechanical, thermal, or shock movement and physical weight of the system

    g. **Seismic** — Relating to vibration caused by an earthquake

    h. **Stanchions** — Vertical components of pipe racks, usually pipe or structural steel

    i. **Struts** — Horizontal components of pipe racks, usually made of structural steel

    j. **Thermal movement** — Any expansion or contraction of the piping system due to a change in temperature associated with the pipe material

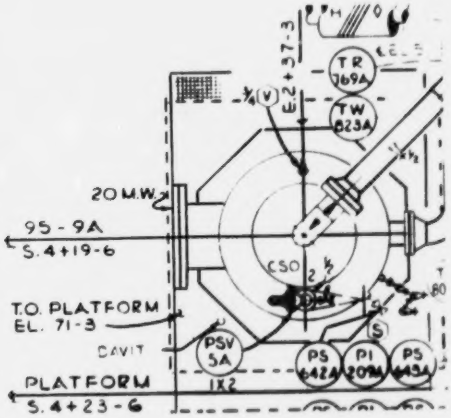
2. **Coordinate system for plan and elevation views**

    a. Plan views use a coordinate system from a known benchmark to mark location of equipment and structures of a facility.

Information Sheet

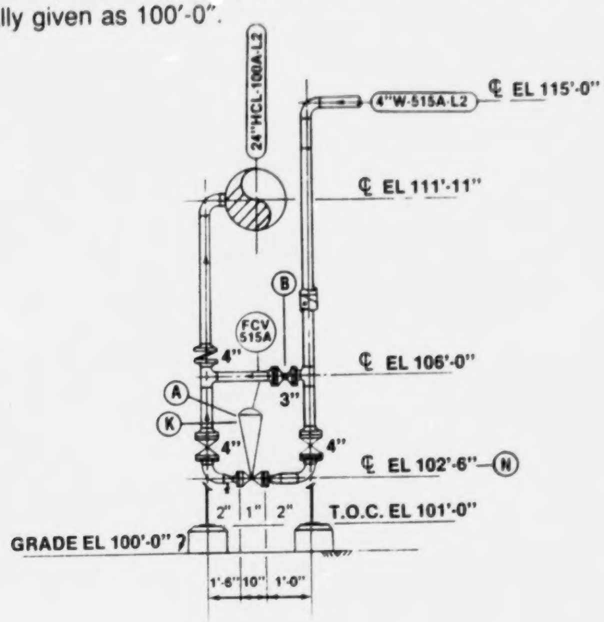
b. Each coordinate line number includes; direction, number of hundred feet, number of feet, and number of inches.

N.1 + 20 – 0	means North of benchmark 120′-0″
E.4 + 23 – 8	means East of benchmark 423′-8″


E.2+37-3
TR 769A
TW 823A
¾ V
1½
20 M.W.
95 - 9A
S.4+19-6
CSO
2 ½
80
T.O. PLATFORM
EL. 71-3
CAVIT
PSV 5A
S
PS 642A
PI 209A
PS 643A
PLATFORM
1X2
S.4+23-6

Courtesy of Phillips Petroleum co.

c. Elevation Drawings note the height above or below grade by giving elevation dimensions to centerlines of pipes, vessel nozzle locations, etc; grade elevation is usually given as 100′-0″.


24"HCL-100A-L2
4"W-515A-L2
℄ EL 115'-0"
℄ EL 111'-11"
B
FCV 515A
4"
℄ EL 106'-0"
3"
A
K
4"
4"
℄ EL 102'-6"
N
2"
1"
2"
T.O.C. EL 101'-0"
GRADE EL 100'-0"
1'-6"
10"
1'-0"

Information Sheet

3. **Abbreviations used on piping plans and elevations**

BD	Blowdown	FS	Far side
BF	Bottom flat or blind flange	GALV	Galvanized
BLDG	Building	GR	Grade
BM	Beam	GRD	Ground
B/M OR BM	Bill of material	GU	Guide
BOC	Bottom of concrete	HDR	Header
BOP	bottom of pipe	HGR	Hanger
BOS	Bottom of steel	HOR or HORIZ	Horizontal
BTM	Bottom	INS	Insulate
CBD	Continuous blowdown	LOC	Location
C to C	Center to center	MATL	Material
CD	Closed drain	MFG	Manufacturing
℄	Clearance or centerline	NPS	National pipe size
CO	Clean out	NS	Near side
COL	Column	OPP	Opposite
COND	Condensate	PL	Plate
CONT	Continuation	PS	Pipe support
CTR	Center	REV	Revision
DF	Drain funnel	SECT	Section
DISCH	Discharge	SMLS	Seamless
EA	Each	SNUB	Snubber
EBD	Emergency blowdown	SPEC	Specification
EL or ELEV	Elevation	SUCT	Suction
EQUIP	Equipment	SUPT	Support
EXCH	Exchanger	SWG	Swage
EXH	Exhaust	TOC	Top of concrete
EXIST	Existing	TOP	Top of pipe
FL	Floor	TOS	Top of steel
FOB	Flat on bottom		

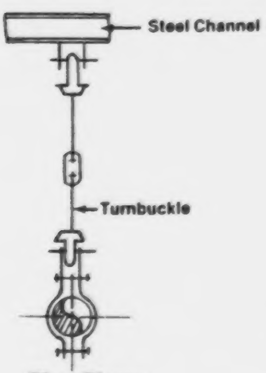
4. **Pipe hangers and their uses**

   a. **Pipe clamp** — Used for noncritical pipe installations

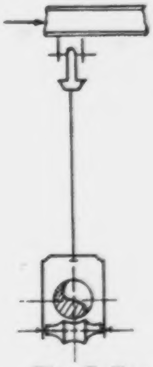
   b. **Pipe roller** — Used for free horizontal movement parallel to the pipe

   c. **Snubber** — Used for protection of piping equipment that is subject to shock loading, swaying,or vibration

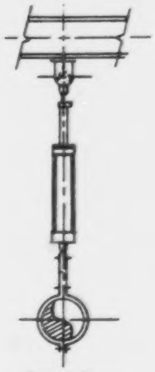
d. **Spring** — Used in combination with other pipe support devices for movement caused by thermal and seismic disturbances


Steel Channel
Turnbuckle

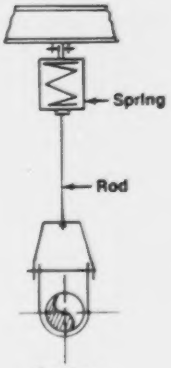
Pipe Clamp



Pipe Roller



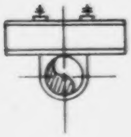
Snubber



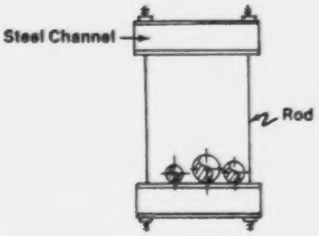
Spring

e. **Anchor** — Used for rigid pipe placement

f. **Rod** — Used for free movement of the pipe in horizontal directions within specified limits

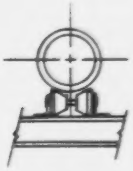


Anchor

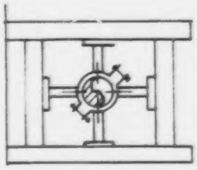

Steel Channel
Rod

Rod

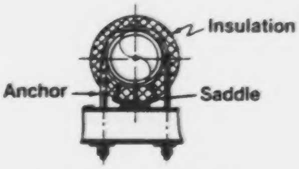
5. **Pipe supports and their uses**



Roller



Pipe Guide


Insulation
Anchor
Saddle

Anchor with Saddle

a. **Roller** — Used for free horizontal movement along the length of the pipe for noninsulated or insulated lines

b. **Guide** — Used for movement of pipe in only one direction, sometimes used in combination with shoe and slide assemblies

Information Sheet

c. **Saddle** — Used for supporting insulated pipes on pipe racks or pipe supports

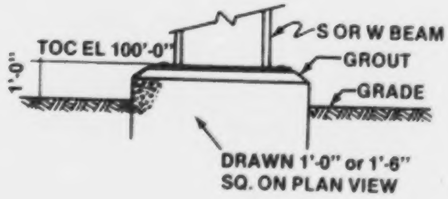
d. **Shoe** — Used on insulated pipes to prevent pipe from crushing insulation

e. **Dummy supports** — Pieces of pipe welded onto pipe used to support the line

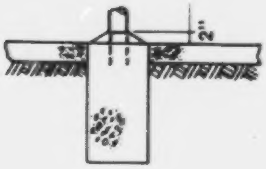
6. **Concrete foundations**

Note: The following information is given as a guide for the beginning pipe drafter, each company has engineers, or standards to ensure the structural integrity of supports for vessels, equipment, and pipe racks.

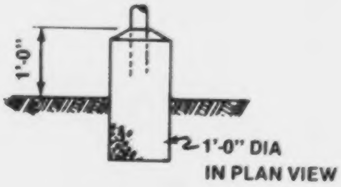
a. Foundations for stanchions or structural steel that have base plates are 1′-0″ above grade.


1'-0"
TOC EL 100'-0"
S OR W BEAM
GROUT
GRADE
DRAWN 1'-0" or 1'-6"
SQ. ON PLAN VIEW

b. Concrete stanchions and steel pipe stanchions with embedded foundations are a minimum of 2″ above paved areas and 1′-0″ above grade in unpaved areas; depth of embedded stanchions are dependent upon amount of weight to be supported.

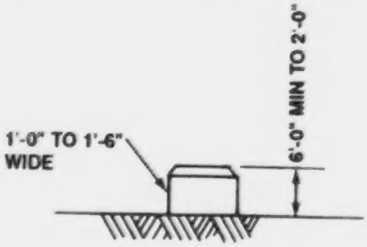


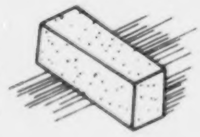
PAVED AREA


1'-0"
1'-0" DIA
IN PLAN VIEW

UNPAVED AREA

c. Pipe piers or sleepers are placed from 6″ to 2′-0″ above grade.

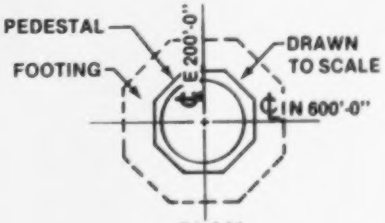

1'-0" TO 1'-6"
WIDE
6'-0" MIN TO 2'-0"



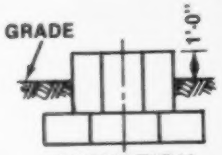
Pipe Pier (Sleeper)

Information Sheet

d. On vessels or columns with skirts or legs, foundations are placed 1′-0″ above grade.

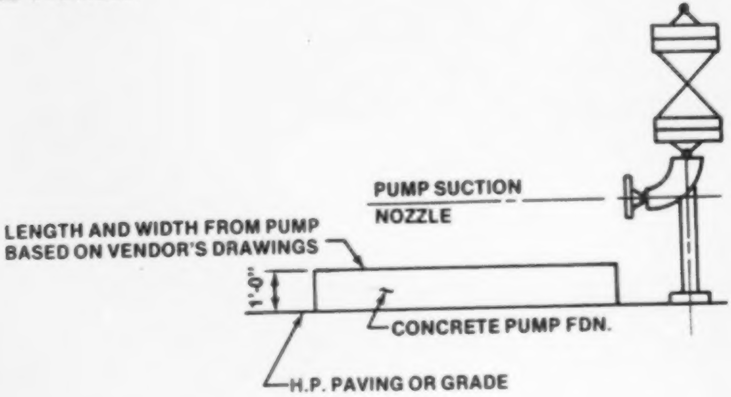

PEDESTAL
FOOTING
E 200'-0"
DRAWN TO SCALE
℄ N 600'-0"

PLAN

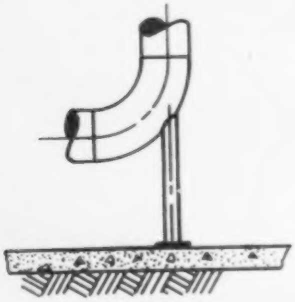


ELEVATION

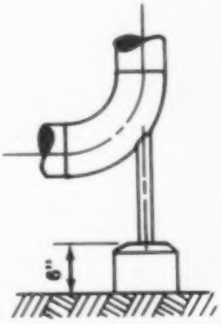
e. Pump foundations or pads are placed 1′0-″ above paving of grade with the dimension often adjusted to place center line of inlet or outlet of pump to a set elevation; the drafter must refer to manufacturers catalog to determine proper pad thickness.


PUMP SUCTION
NOZZLE
LENGTH AND WIDTH FROM PUMP BASED ON VENDOR'S DRAWINGS
1'-0"
CONCRETE PUMP FDN.
H.P. PAVING OR GRADE

f. Dummy support base is placed flat on concrete in paved areas and 6″ above grade in unpaved areas, usually on a sleeper.



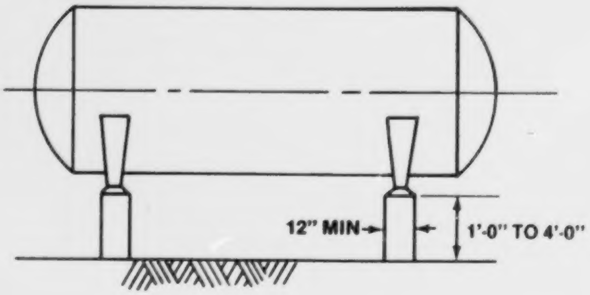
PAVED AREA



UNPAVED AREA

Information Sheet

g. Horizontal vessel foundations are placed from 1′-0″ to 4′-0″ above grade to allow for proper clearance.



7. Pipe racks

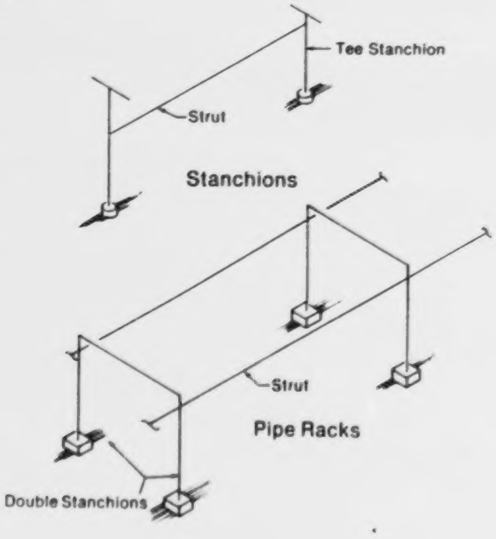
a. Racks consist of steel channel, I beams, pipe, or precast concrete members.

b. Stanchions consist of structural steel, pipe, or precast concrete vertical members.

c. Struts are used for structural stability between pipe racks.

d. Elevated pipe racks are used to permit access around equipment and process areas.

e. Pipe racks are used for multiple parallel pipe runs, and for spanning great distance pipe runs.



Stanchions

Pipe Racks

Information Sheet

8. Guidelines for placing pipe on pipe racks

a. Place heavy, large diameter pipe lines on outer edges.

b. Place process lines on the side nearest the equipment and on the top layer of a multiple-level pipe racks.

c. Place piping loops for expansion over the top of the pipe rack; for multiple-level pipe racks, allow clearance for loops between levels of the pipe rack.

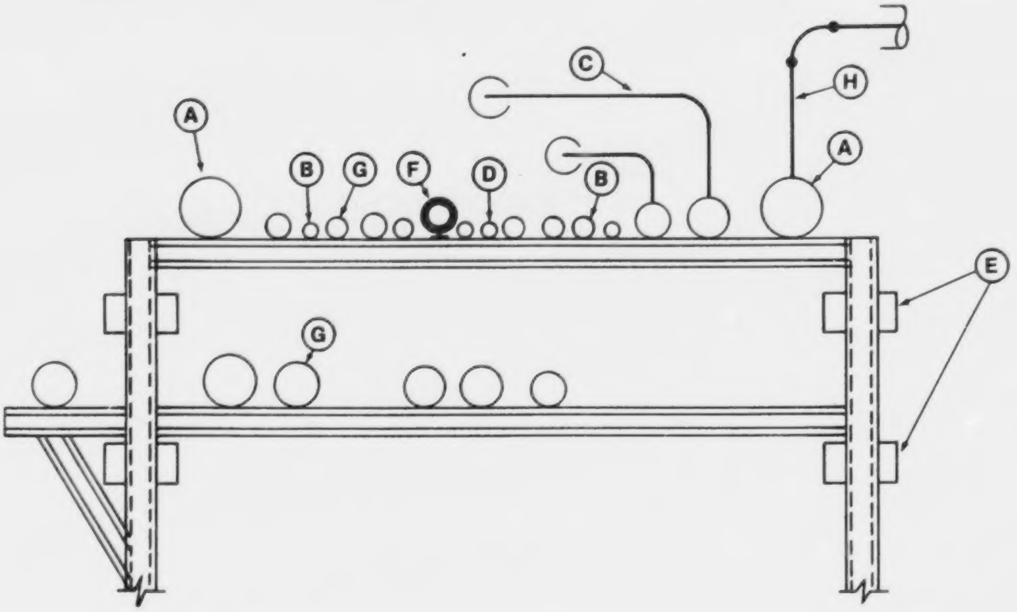
d. Support small diameter pipes of shorter span distances with shoes or bracing.

e. Arrange instrument lines and conduit lines on the outside of the pipe racks to allow quick access for maintenance and reworking.

f. Support insulated lines on shoes and in some cases, on slide arrangements to retard breaking of thermal barrier.

g. Lay noninsulated lines directly on the pipe rack, if needed.

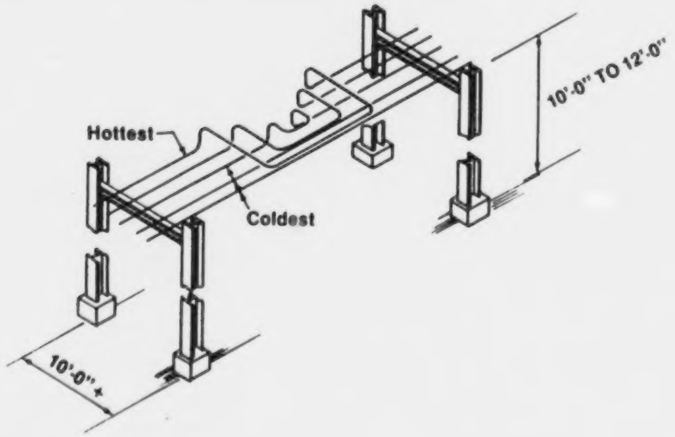
h. Extend take-off lines from the pipe rack usually 90° vertical or horizontal from the main line.



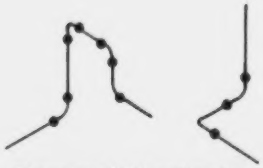
Information Sheet

9. Methods of providing piping flexibility and their applications

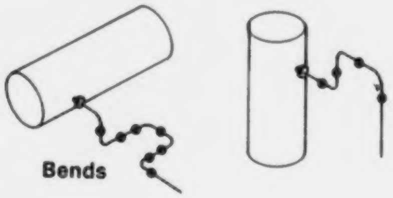
a. **Bends** — L, C, or U shapes used in piping systems that undergo high temperature and/or high pressure operations


Hottest
Coldest
10'-0" TO 12'-0"
10'-0"+

b. **Offsets** or **Change-of-directions** — Used in piping systems to relieve thermal stress

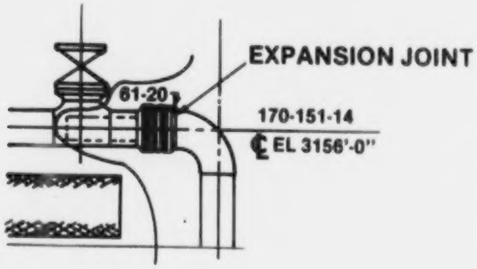


Change of Direction for Thermal Stressed Lines



Bends

c. **Expansion joints** — Used in low pressure and/or low temperature operations where vibration is often the largest concern


EXPANSION JOINT
61-20
170-151-14
℄ EL 3156'-0"

Information Sheet

10. Types of insulation and their applications

a. **Wool felt** — Used on hot and cold water lines up to 212°F

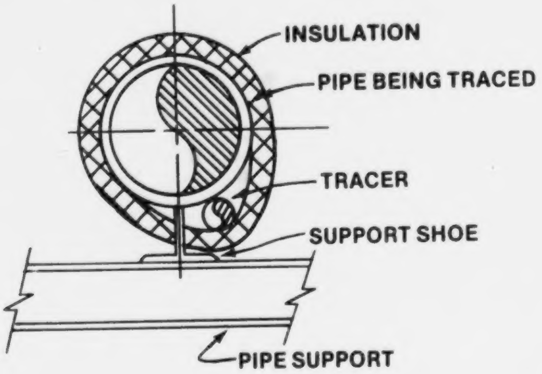
b. **Rock or vegetable cork** — Used for low thermal conductivity and high moisture resistance

c. **Fiberglass** — Rigid, structural insulation used for temperatures up to 600°F

d. **Aluminum armored** — Calcium silicate and asbestos fiber material with aluminum jacket used for steam and process lines for temperatures of 600° to 1200°F

e. **Steam tracing** — Steam tubing wrapped around a pipe to keep liquids from freezing, to keep viscous liquid from setting up, and to vaporize small amounts of condensate that may form in a vapor system

Note: Electric heating lines are often used for the same purposes.



11. Abbreviations for types of insulation

a. **C** — Cold

b. **H** — Hot

c. **HP** — Hot Personal

d. **HF** — Hot freeze Protection

e. **ST** — Steam Trace

f. **HT** — Heat Trace

Piping Plans and Elevations
Unit 5

Assignment Sheet 1—Draw a Piping Plan View

Name ______________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Drawn to scale	______
Room correctly laid out	______
New construction labeled	______
Equipment correctly placed	______
Equipment correctly dimensioned	______

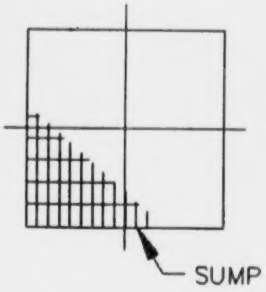
Directions: Use the accompanying floor plan of a room, Drawing C-48, and plan view drawings of equipment as your guide. Place and dimension equipment in the room and plot at 3/8″=1′-0″
scale on page C-48.

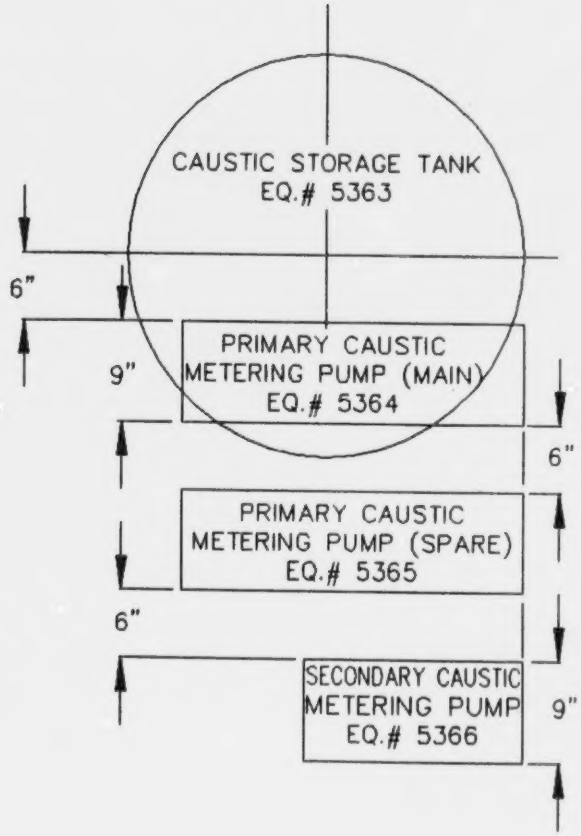
Procedure

1. Locate sump 18″ square 4′-8″ east from ctr of NW column and to ctr of grate 1′-0″ from existing north wall to north edge of sump grate.
2. Locate center of caustic storage tank 2′-0″ east and 3′-0″ south of walls that join at NW column.
3. Locate pumps EQ #5364, #5365, and #5366 according to sketch.
4. Place waste and neutralization tank EQ #5360 2′-0″ from north wall and 18″ from east wall.
5. Locate ℄ of reactor separator tank EQ #5362 7′-0″ east of east wall and 6′-0″ from north wall outside of room.
6. Plot all entries to 3/8″ = 1′-0″ scale, properly scale all equipment, and label and place equipment in the room, except EQ #5362.

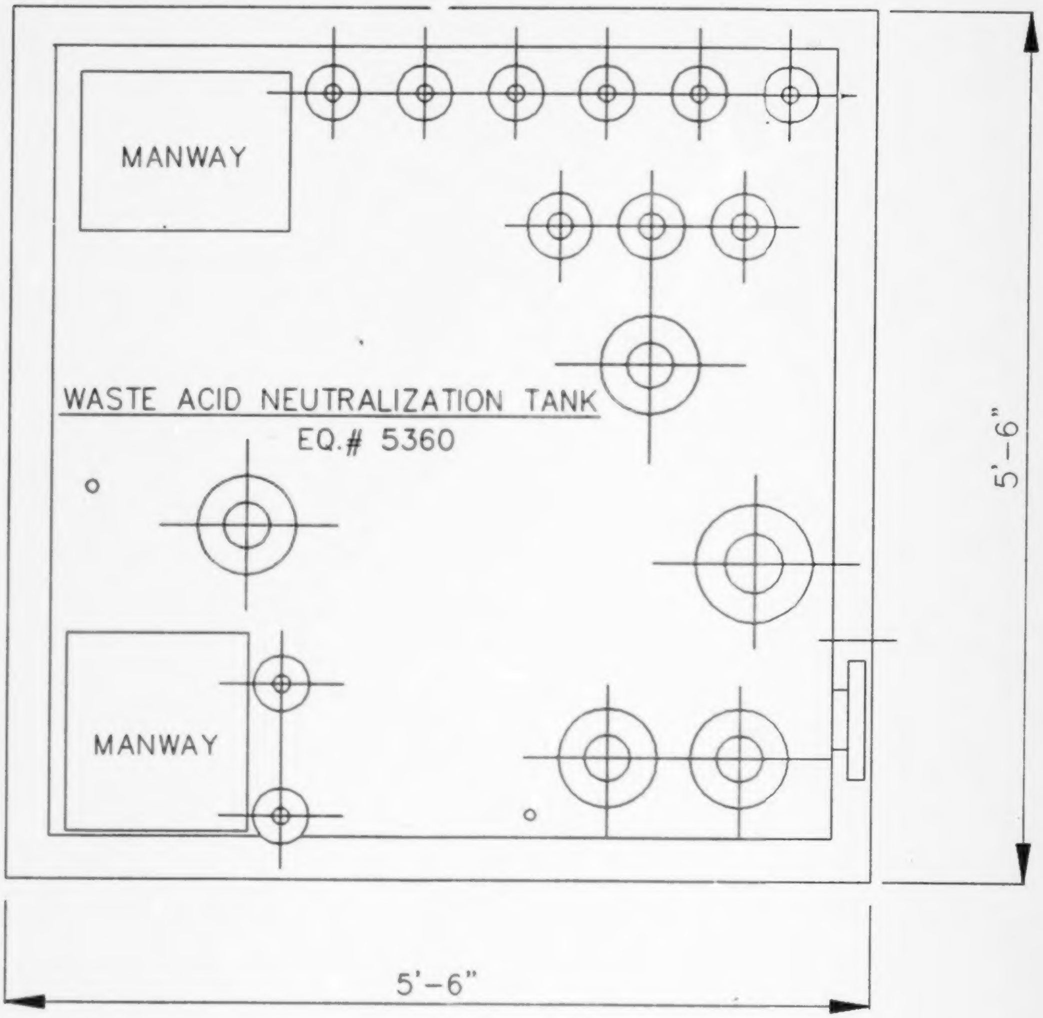
Note: The graphic materials to help you complete this assignment are on the following four pages so you will be able to look at all the equipment together to help with your planning.

Assignment Sheet 1

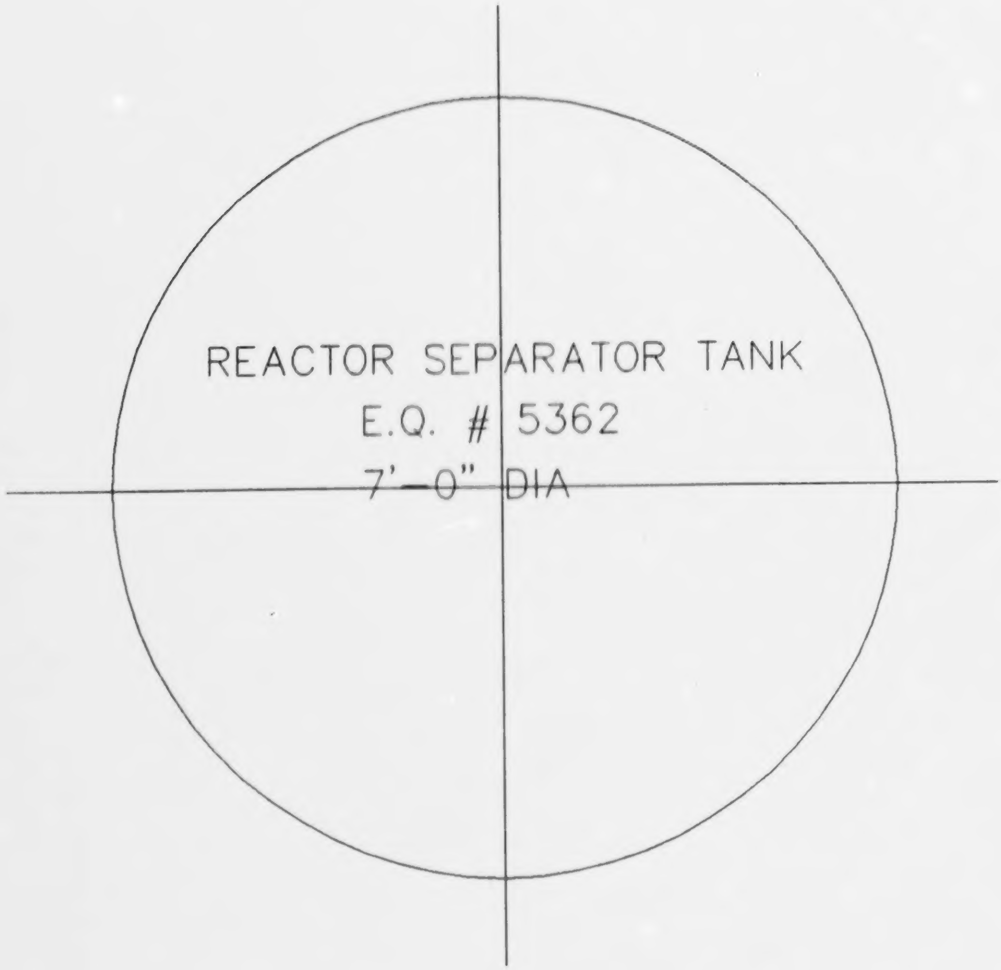



CAUSTIC STORAGE TANK
EQ.# 5363
6"
9"
PRIMARY CAUSTIC
METERING PUMP (MAIN)
EQ.# 5364
6"
PRIMARY CAUSTIC
METERING PUMP (SPARE)
EQ.# 5365
6"
SECONDARY CAUSTIC
METERING PUMP
EQ.# 5366
9"

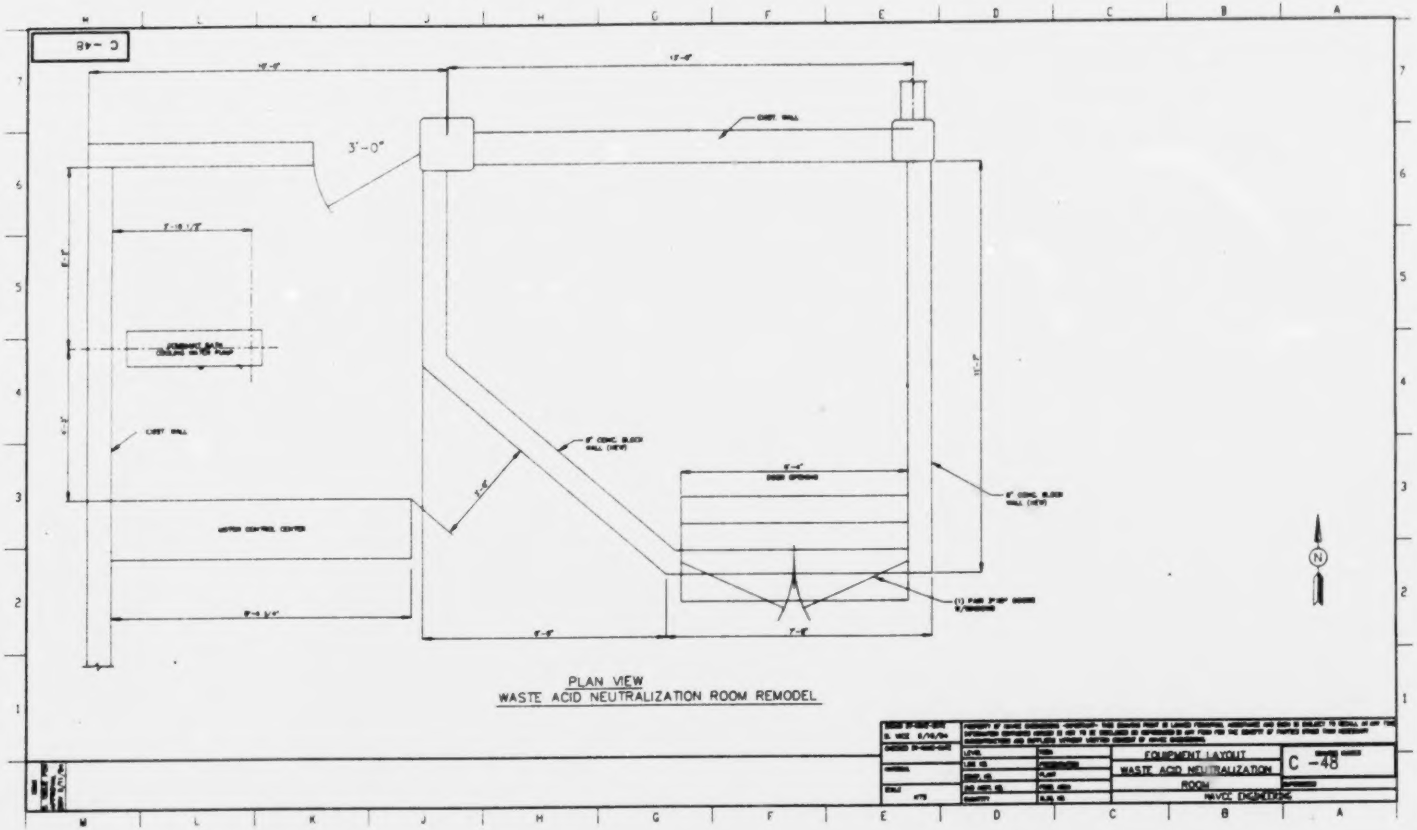
Assignment Sheet 1


MANWAY
WASTE ACID NEUTRALIZATION TANK
EQ.# 5360
MANWAY
5'–6"
5'–6"

Assignment Sheet 1


REACTOR SEPARATOR TANK
E.Q. # 5362
7'–0" DIA

Assignment Sheet 1


C -48
3'-0"
MOTOR CONTROL CENTER
DOOR OPENING
8" CONC. BLOCK WALL (NEW)
EQUIPMENT LAYOUT
WASTE ACID NEUTRALIZATION
ROOM
C -48
M
L
K
J
H
G
F
E
D
C
B
A
7
6
5
4
3
2
1

PLAN VIEW
WASTE ACID NEUTRALIZATION ROOM REMODEL

BEST COPY AVAILABLE

Piping Plans and Elevations
Unit 5

Assignment Sheet 2—Draw a Piping Section View

Name ______________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Complete title block	______
Section correctly identified	______
Elevations correctly marked	______
Platforms correctly identified	______
Pipe symbols correctly drawn	______
Ladders clearly drawn	______
Drawn to scale	______

Directions: Use the accompanying plan view of a wash water settler, dwg# 258-5016 and a list of elevations to draw a section view. Plot the drawing at 3/8″ = 1′-0″ scale.

List of Elevations and Grade

1. AVERAGE GRADE 39′-0″

2. PUMP-DMPC TOC PLATFORM 40′-0″
   ℄ OF PUMP 40′-0″
   FOF DISCHARGE 41′-0″

3. WASH WATER SETTLER 16′ DIA X 41′-S TO S
   BFS-CA-900 ℄ OF VESSEL 55′-6″
   PS37-13 TYPICAL TOC 49′-0″
   FOF FOR PIPE 10″ B-PR-121 62′-6 1/16″
   FOF FOR PIPE 12″ A-HF-109 62′-4 1/16″
   ℄ FOR PIPE 10″ BFS-SH-102 53′-6″
   ℄ FOR PIPE 6″ BFS7-CA-114 46′-6″

4. EAST PLATFORM 12′ X 16′
   T.O. PLATFORM 62′-6″
   T.O. LADDER 65′-6″
   B.O. LADDER CAGE 47′-0″ (LADDER TO GO TO GRADE)

5. MIDDLE PLATFORM 6′ X 12″
   T.O. PLATFORM 44′-0″
   T.O. LADDER 57′-0″
   B.O. LADDER CAGE 51′-0″ (LADDER TO GO TO GRADE)

Assignment Sheet 2

List of Elevations and Grade (cont.)

6. PIPE SUPPORT PS 37-1
   - 2 VERTICAL
   - 2 HORIZONTAL ELEMENTS TOS 52′0″ TOS 58′-0″

7. PIPES
   - #4″ BFS-CA-115 43′-2 13/16″
   - #6″ BFS-CA-114 40′-8 11/16″
   - #6″ BFS-CA-115 40′-8 11/16″

General Pipe Layout

PIPE #10″ B-PR-121: LEAVES SETTLER AT TOP WEST FLANGE UPWARD TO ELEV 64′-11 13/16″ ℄ - THEN WEST 7′-5″, THEN DOWN TO PS37-1 (TOS-BOB) 58′-0″, THEN SOUTH TO TEE AND BLIND FLAGE ABOVE STAIRS.

PIPE #6″ BFS-CA-115: BEGINS AT SOUTHWEST SIDE OF DWG (C-2) AT ℄ ELEV 40′-8 11/16″, THEN NORTH TO REDUCING TEE FOR LINE #4″ BFS-CA-115, AND CONTINUES NORTH TO END OF PIPE RACK, THEN RISES TO BOB 52′-0″, AND RETURN SOUTH.

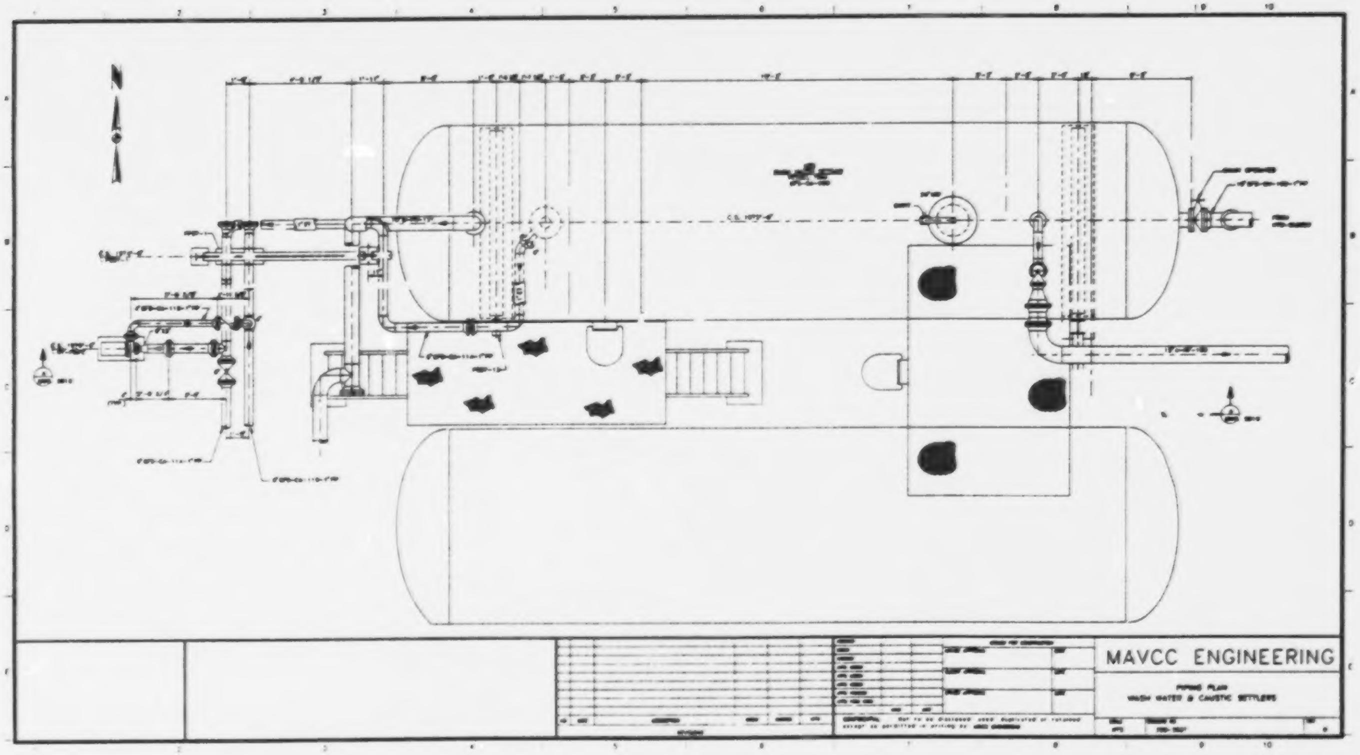
PIPE #6″ BFS-CA-114: BEGINS AT QUADRANT C-2, ELEV 40′-8 11/16″, THEN NORTH TO SUCTION SIDE OF PUMP, AND CONTINUES NORTH, RISES BEFORE PS37-1 TOF 45′-6″ ELEV, THEN NORTH, WEST, SOUTH, WEST, NORTH OT POT ON BOTTOM OF SETTLER.

PIPE #4″ BFS-CA-115: BEGINS AT PUMP DISCHARGE FOF 41′-6 1/2″, RISES TO ℄ ELEV 43′-2 13/16″, THEN NORTH, WEST, AND DOWN TO REDUCING TEE ON LINE #6″BFS-CA-115.

PIPE #10″ BFS-SH-102: FROM ℄ ELEV 61′-8″ DOWN AND INTO SETTLER AT ℄ ELEV 53′-6″.

PIPE #12″ A-HF-109: FROM FOF ELEV 62′-4 1/16″ AT TOP AND EAST OF SETTLER UP TO ELEV 67′-10 3/8″, THEN SOUTH THRU REDUCERS, THEN WEST TO NDISCHARGE.

Assignment Sheet 2


MAVCC ENGINEERING
PIPING PLAN
WASH WATER & CAUSTIC SETTLERS
N

EST COPY AVAILABLE

Piping Plans and Elevations
Unit 5

Assignment Sheet 3—Draw a Piping Plan and Elevation

Name ____________________ Overall Rating ____________

Evaluation criteria	**Rating**
Drawn to scale	______
Grade and elevation correctly marked	______
Pipe symbols correctly drawn	______
Plan and section clearly marked	______
Plan and section correctly dimensioned	______
Dimensions correctly calculated	______
Length of pipe correct	______
Complete list of fittings	______

Directions: Use the accompanying plan view sketch of the hookup for a depropanizer (31-2) and deoiler (30-2) to draw a complete plan view and elevation A-A on page C-31-A. Plot to 3/8" = 1'-0" scale. Calculate dimensions a and b, calculate length of pipes required, and complete a list of required fittings. Make all your entries on the answer sheet that follows:

Answer Sheet

Dimension a: ____________________

Dimension b: ____________________

Note: Pipe 1 begins at the depropanizer, and pipe 5 to end at deoiler.

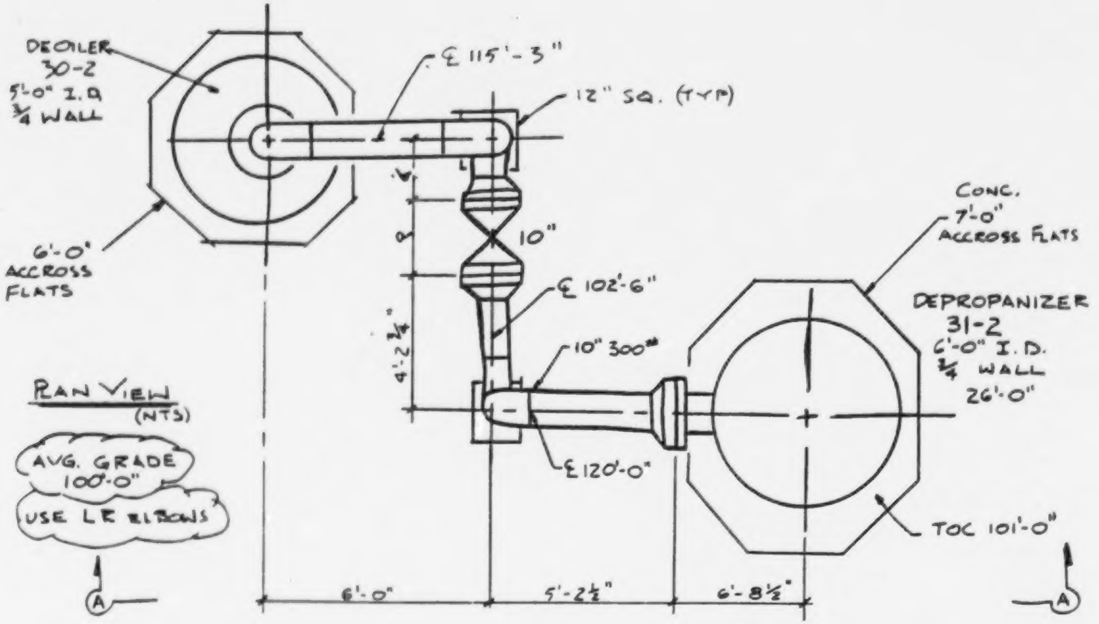
Pipe 1: ____________________
Pipe 2: ____________________
Pipe 3: ____________________
Pipe 4: ____________________
Pipe 5: ____________________

Fittings

Note: Do not list RFWN on vessels.

No.	Qty.	Description
______	______	____________________
______	______	____________________
______	______	____________________

Assignment Sheet 3


DEOILER
30-2
5'-0" I.D.
¾ WALL
6'-0" ACCROSS FLATS
℄ 115'-3"
12" SQ. (TYP)
10"
℄ 102'-6"
4'-2¾"
10" 300#
℄ 120'-0"
CONC.
7'-0" ACCROSS FLATS
DEPROPANIZER
31-2
6'-0" I.D.
¾ WALL
26'-0"
TOC 101'-0"
PLAN VIEW
(NTS)
AVG. GRADE 100'-0"
USE LR ELBOWS
A
A
6'-0"
5'-2½"
6'-8½"

Isometrics
Unit 6

Objective Sheet

Unit Objective

After completing this unit, the student should be able to fill out a BOM (Bill of Material) and calculate pipe lengths, and draw spool drawings from an isometric drawing. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to isometrics with their correct definitions.
2. Select true statements about purposes of isometric and spool drawings.
3. Identify information on the drawing side of an isometric/spool drawing.
4. List types of information on the BOM side of an isometric/spool drawing.
5. Complete a chart of single line isometric symbols.
6. Select true statements about isometric fitting representation.
7. Differentiate between correct and incorrect procedures for dimensioning isometrics.
8. Select true statements about guidelines for dimensioning angle and rolled offsets.
9. Draw and correctly place a north arrow using the preferred method.
10. Draw and letter an instrumentation balloon.

Objective Sheet

11. Complete statements about drawing connecting lines and numbers.
12. Solve problems about guidelines for drawing and placing vents and drains.
13. Select true statements about guidelines for drawing and placing shop and field erection marks.
14. Complete statements about drawing and noting dummy supports.
15. Fill out a BOM and calculate lengths of pipe, Part A. (Assignment Sheet 1)
16. Fill out a BOM and calculate lengths of pipe, Part B. (Assignment Sheet 2)
17. Draw spool drawings from Isometric A. (Assignment Sheet 3)
18. Draw spool drawings from Isometric B. (Assignment Sheet 4)
19. Draw spool drawings from Isometric C. (Assignment Sheet 5)

Isometrics
Unit 6

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan for enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from the transparency masters included with this unit. These appear in the teacher guide only and are designed to be used with the following objectives:

   TM 1—Isometric Pipe Drawing (Objective 2)
   TM 2—Spool Drawing (Objective 3)
   TM 3—Spool Drawing (Continued) (Objective 3)
   TM 4—Spool Drawing (Continued) (Objective 3)
   TM 5—Bill of Material (Objective 4)

5. Develop teaching plan. Adjust for different learning styles.

6. Make copies of Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.

8. Discuss unit and specific objectives.

9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic skills when applicable.

10. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Suggested Activities

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings, job sheet ratings, and written test scores on the Unit Evaluation Form. Include any additional assignments.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Take maximum advantage of the transparency masters. In addition to using them to help demonstrate the materials in Objective 3 and 4, use them to show students how to select individual spools from an isometric. The TMs mirror the activities students must complete in the final three job sheets. Impress upon students the importance of selecting a correct spool before continuing with a complete spool drawing. Use the TMs again on Objective 13. Demonstrate how marks are used to isolate individual spools. Skill area: **Learning skills, learning to learn.**

2. Since the assignment sheets are complex activities, review both the assignment sheets and answers to the assignment sheets with care. In assignment sheets 1 and 2, the complete bill of material is given in the answer. You may want to check or otherwise mark only the required answers to accelerate grading.

3. Have examples of north arrow placement from working drawings. Pass them around so students will have a better grasp of the materials in Objective 7. If you can find a good example of the alternate method for placing the north arrow, show students why it was used instead of the preferred method. Skill area: **Foundation skills, reading and listening.**

Suggested Activities

Resources Used in Developing This Unit

1. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.
2. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division/McGraw-Hill Book Co., 1981.
3. Weaver, Rip. *Process Piping Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Supplemental Resources

The 6th edition of *The Piping Handbook* by M. L. Nayyar is available from McGraw Hill. This edition was published in 1992. For information about a review copy, dial 1-800-338-3987, and then press 2. Write to:

McGraw-Hill Book Company
1221 Avenue of the Americas
New York, NY 10017

The Gulf Publishing Company of Houston has three video series dedicated to helping beginning and intermediate pipe drafters relate to the enormous range of materials, procedures, and references that pipe drafting requires. One program is a 10-part series titled *Piping Fundamentals*, designed for the beginning drafter, the follow up series is a 13-part video titled *Piping Familiarization*, designed for the intermediate drafting student. Another intermediate series is a 5-part video titled *Piping Pointers*, another production for intermediate students. For information, call toll-free 1-800-231-6275 or 713-529-4301. Videos are available in all formats with a 10% educational discount. For more information, write to Gulf at:

Gulf Publishing
Book Division
P.O. Box 2608
Houston, TX 77252-2608

Isometrics
Unit 6

Answers to Assignment Sheets

Assignment Sheet 1

Spool Drawing 1

7	4	ELBOW	3" SCH 40 90 LR BW	A234-WPB
6	1	ELBOW	3" SCH 40 45 LR BW	A234-WPB
5	1	PIPE	3" SCH 40 X 4'-7 5/8" LG. (BBE)	A53-Gr. B
4	1	PIPE	3" SCH 40 X 4'-5 1/2" LG. (BBE)	A53-Gr. B
3	1	PIPE	3" SCH 40 X 4'-3" LG. (BBE)	A53-Gr. B
2	1	PIPE	3" SCH 40 X 1'-2 3/4" LG. (BBE)	A53-Gr. B
1	1	PIPE	2" S/40 X 3'-7" LG.(TRIM)(PE-NOZ)	A106-Gr. B
ITEM	QTY.	DESCRIPTION		

Spool Drawing 2

7	1	SOCKOLET	1" 3000# ON 8" SW	A105
6	2	WELDOLET	6" SCH 20 ON 8" BW	A105
5	1	ELBOW	8" SCH 20 90 LR BW	A234-WPB
4	2	ELBOW	8" SCH 20 45 LR BW	A234-WPB
3	1	FLANGE	8" 300# RF WN SCH 20	A105
2	1	PIPE	8" SCH 20 X 40'-9" LG. (BBE) △1	A53-Gr. B
1	1	PIPE	8" SCH 20 X 1'-3 7/16" LG. (BBE)	A53-Gr. B
ITEM	QTY	DESCRIPTION		

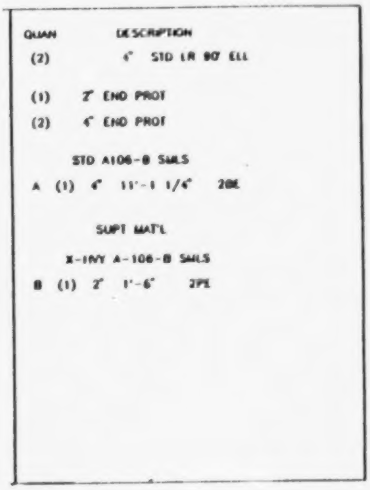
Spool Drawing 3

9	1	LATEROLET	1 1/2" SCH 80 ON 8" BW	A105
8	1	ELBOW	8" SCH 20 90 LR BW	A234-WPB
7	1	ELBOW	8" SCH 20 45 LR BW	A234-WPB
6	1	FLANGE	8" 300# RF WN SCH 20	A105
5	1	FLANGE	1 1/2" 300# RF WN SCH 80	A105
4	1	PIPE	8" SCH 20 X 4'-11 3/8" LG. (BBE)	A53-Gr. B
3	1	PIPE	8" SCH 20 X 2'-1 7/16" LG. (BBE)	A53-Gr. B
2	1	PIPE	8" SCH 20 X 1'-2 5/16" LG. (BBE)	A53-Gr. B
1	1	PIPE	1 1/2" SCH 80 X 6" LG.(TRIM) (BBE)	A106-Gr. B
ITEM	QTY	DESCRIPTION		

Answers to Assignment Sheets

Assignment Sheet 2

Spool Drawing 1



QUAN DESCRIPTION

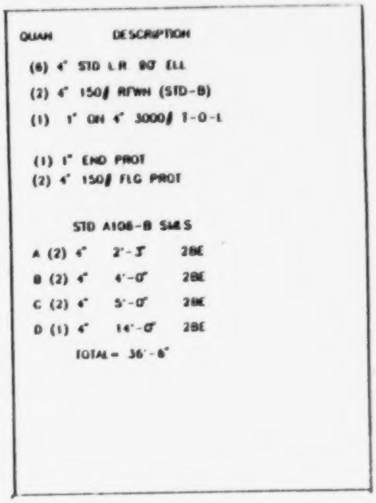
(2) 4" STD LR 90° ELL

(1) 2" END PROT
(2) 4" END PROT

STD A106-B SMLS
A (1) 4" 11'-1 1/4" 2BE

SUPT MAT'L
X-HVY A-106-B SMLS
B (1) 2" 1'-6" 2PE

Spool Drawing 2



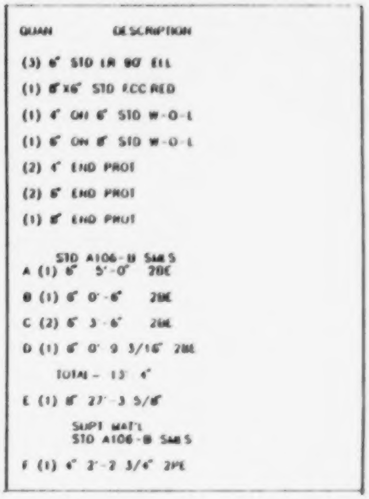
QUAN DESCRIPTION

(6) 4" STD LR 90° ELL
(2) 4" 150# RFWN (STD-B)
(1) 1" ON 4" 3000# T-O-L

(1) 1" END PROT
(2) 4" 150# FLG PROT

STD A106-B SMLS
A (2) 4" 2'-3" 2BE
B (2) 4" 4'-0" 2BE
C (2) 4" 5'-0" 2BE
D (1) 4" 14'-0" 2BE
TOTAL = 36'-6"

Spool Drawing 3



QUAN DESCRIPTION

(3) 6" STD LR 90° ELL
(1) 8"x6" STD ECC RED
(1) 4" ON 6" STD W-O-L
(1) 6" ON 8" STD W-O-L
(2) 4" END PROT
(2) 6" END PROT
(1) 8" END PROT

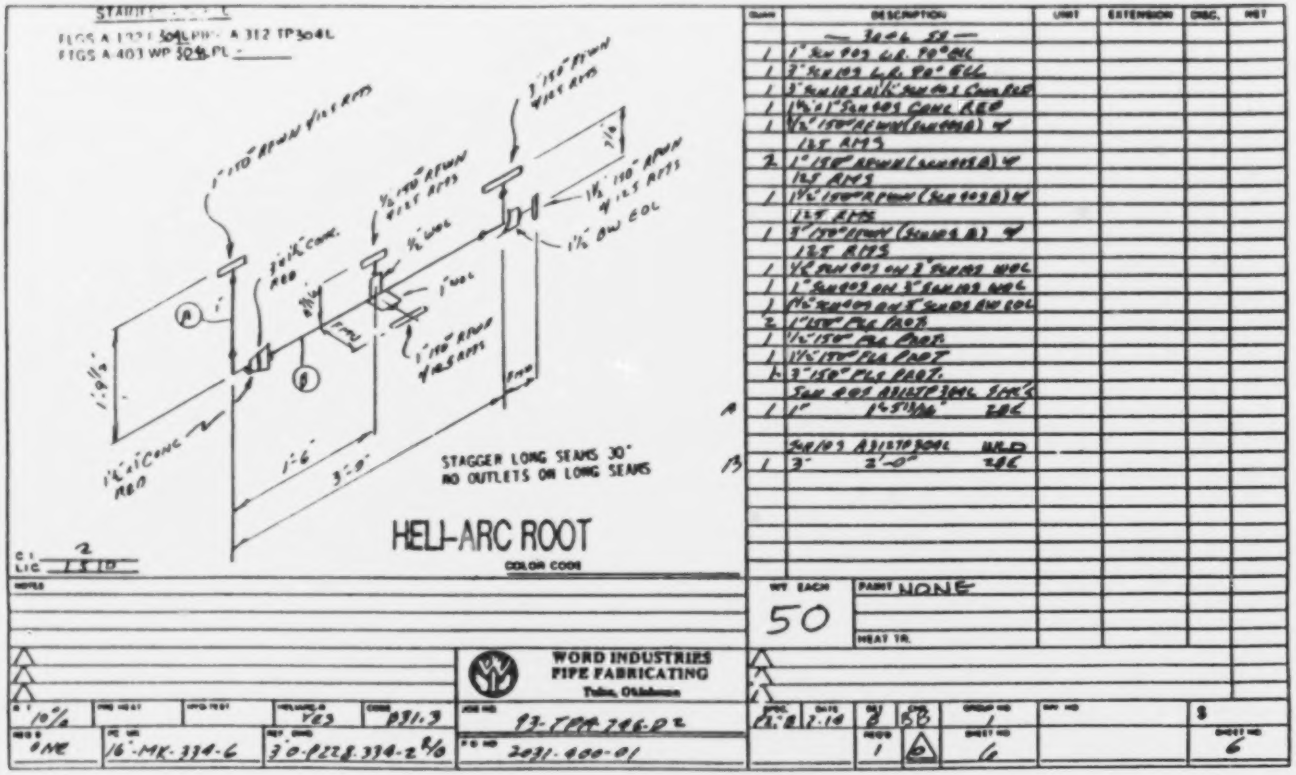
STD A106-B SMLS
A (1) 6" 5'-0" 2BE
B (1) 6" 0'-6" 2BE
C (2) 6" 3'-6" 2BE
D (1) 6" 0'-9 3/16" 2BE
TOTAL – 13'-4"
E (1) 8" 27'-3 5/8"

SUPT MAT'L
STD A106-B SMLS
F (1) 4" 2'-2 3/4" 2PE

Answers to Assignment Sheets

Assignment Sheet 3

Spool 1 from Isometric A


1" 150# RFWN w/ 125 RMS
3" 150# RFWN w/ 125 RMS
½" 150# RFWN w/ 125 RMS
½" WOL
1½" 150# RFWN w/ 125 RMS
1½" BW EOL
3" x 1½" CONC. RED
1" WOL
1" 150# RFWN w/ 125 RMS
1½" x 1" CONC RED
A
B
1'
1'-9 11/16"
1'-6"
3'-9"
1'-6"

STANDARD
FLGS A 182 F 304L PIPE A 312 TP304L
FTGS A 403 WP 304L PL —

STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS

HELI-ARC ROOT
COLOR CODE

C.I. 2
LIC 1510

QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	— 304L SS —				
1	1" Sch 40S L.R. 90° ELL				
1	3" Sch 10S L.R. 90° ELL				
1	3" Sch 10S x 1½" Sch 40S Conc Red				
1	1½" x 1" Sch 40S Conc Red				
1	½" 150# RFWN (Sch 40S B) w/				
	125 RMS				
2	1" 150# RFWN (Sch 40S B) w/				
	125 RMS				
1	1½" 150# RFWN (Sch 40S B) w/				
	125 RMS				
1	3" 150# RFWN (Sch 10S B) w/				
	125 RMS				
1	½" Sch 40S on 3" Sch 10S WOL				
1	1" Sch 40S on 3" Sch 10S WOL				
1	1½" Sch 40S on 3" Sch 10S BW EOL				
2	1" 150# Flg Prot.				
1	½" 150# Flg Prot.				
1	1½" 150# Flg Prot				
1	3" 150# Flg Prot.				
	Sch 40S A312TP304L Smls				
A 1	1" 1'-5 11/16" 2BE				
	Sch 10S A312TP304L WLD				
B 1	3" 2'-0" 2BE				

NOTES

WT EACH 50
PAINT NONE
HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

X-RAY 10%
HYDRO TEST YES
CODE B31.3
JOB NO 93-TPA-296-D2
REQ'D ONE
PC NO 16"-MK-334-6
REF DWG 3"0-P228.334-2 R/0
P.O. NO 2031-400-01
DATE 7-10
DR 8
CHK BB
GROUP NO 1
REV 1
SHEET NO 6
SHEET NO 6

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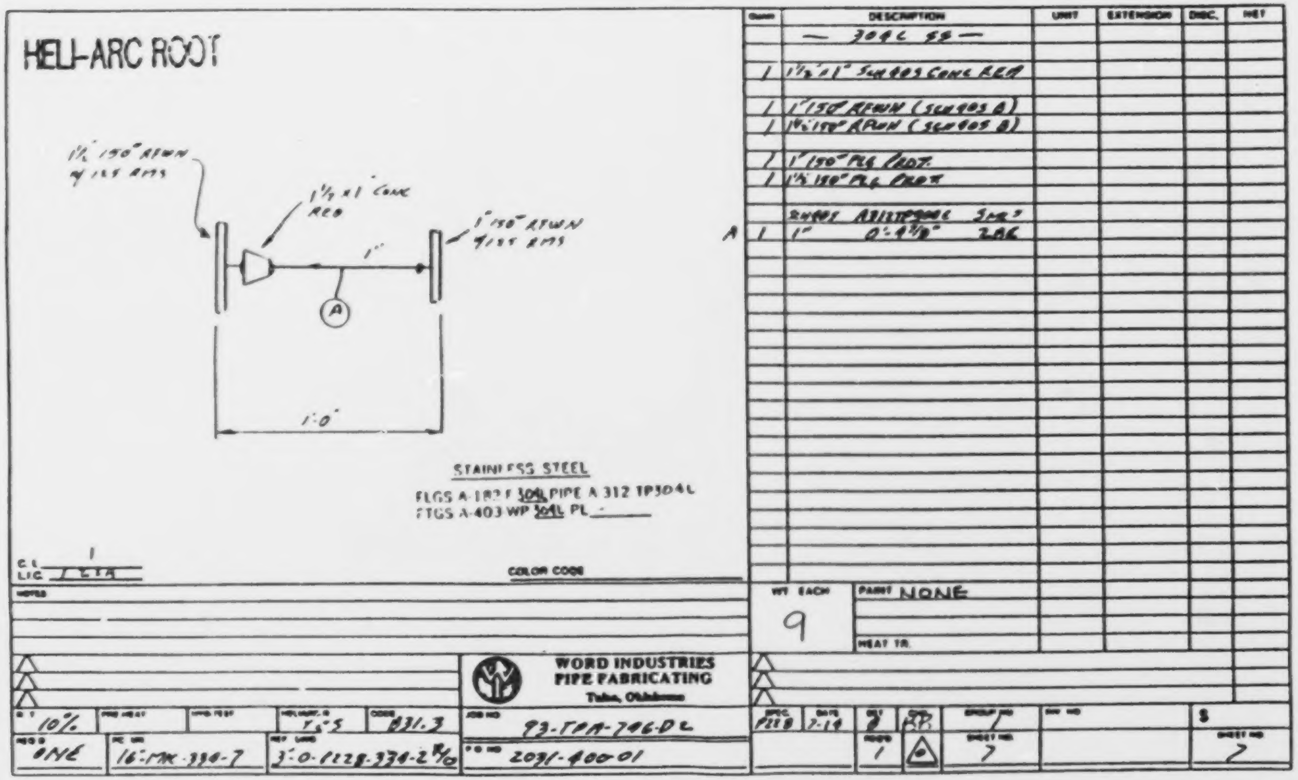
Answers to Assignment Sheets

Assignment Sheet 3

Spool 2 from Isometric A



STAINLESS STEEL
FLGS A-182 F 304L PIPE A 312 TP304L
FTGS A-403 WP 304L PL -

C.L. 1
L.I.C. I 61A

COLOR CODE

NOTES

		DESCRIPTION	UNIT	EXTENSION	DISC.	NET
		— 304L SS —				
	1	1½" x 1" SCH 40S CONC RED				
	1	1" 150# RFWN (SCH 40S B)				
	1	1½" 150# RFWN (SCH 40S B)				
	1	1" 150# FLG PROT.				
	1	1½" 150# FLG PROT				
		PIPE A312TP304L SMLS				
A	1	1" 0'-9⅞" [illegible]				

WT EACH 9

PAINT NONE

HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

R.T. 10%

HELIARC. T&S

CODE B31.3

JOB NO 93-TPA-746-DC

REQ'D ONE

PC NO 16-MK-334-7

REF LINE 3"-0-1228-334-2 B/C

P.O. NO 2031-400-01

SPEC P228

DATE 7-14

CHK'D BB

GROUP NO 1

REQ'D 1

SHEET NO 7

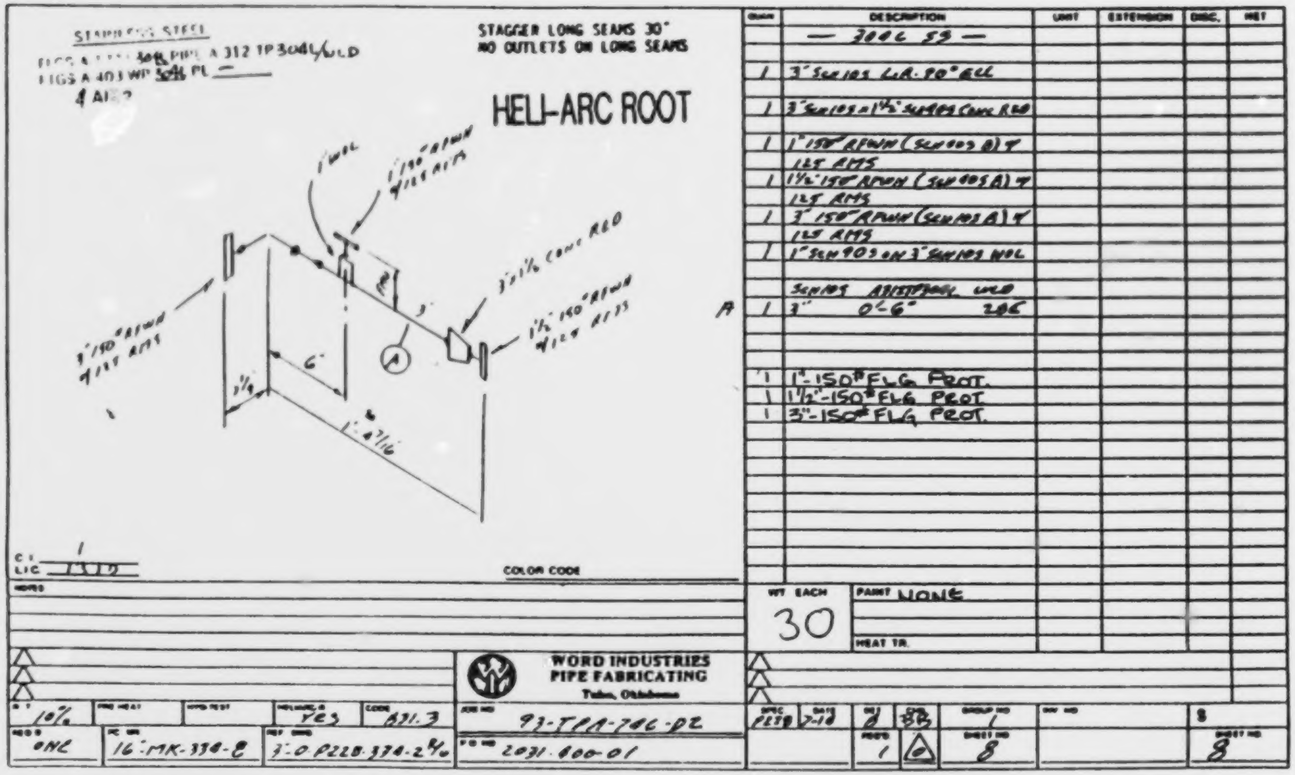
SHEET NO 2

BEST COPY AVAILABLE

Answers to Assignment Sheet

Assignment Sheet 3

Spool 3 from Isometric A



STAINLESS STEEL
FLGS A [illegible] 304L PIPE A 312 TP304L/WLD
FTGS A 403 WP 304L PL —
& AI[illegible]

STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS

HELI-ARC ROOT

[illegible]	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	— 304L SS —				
1	3" Sch 10S L.R. 90° ELL				
1	3" Sch 10S x 1½" Sch 40S Conc Red				
1	1" 150# RFWN (Sch 40S A) & 125 RMS				
1	1½" 150# RFWN (Sch 40S A) & 125 RMS				
1	3" 150# RFWN (Sch 10S A) & 125 RMS				
1	1" Sch 40S on 3" Sch 10S WOL				
	Sch 10S A312TP304L WLD				
A 1	3" 0'-6" 206				
1	1"-150# FLG PROT.				
1	1½"-150# FLG PROT.				
1	3"-150# FLG PROT.				

C.I. 1
LIC 1312

COLOR CODE

NOTES

WT EACH 30

PAINT NONE

HEAT TR.

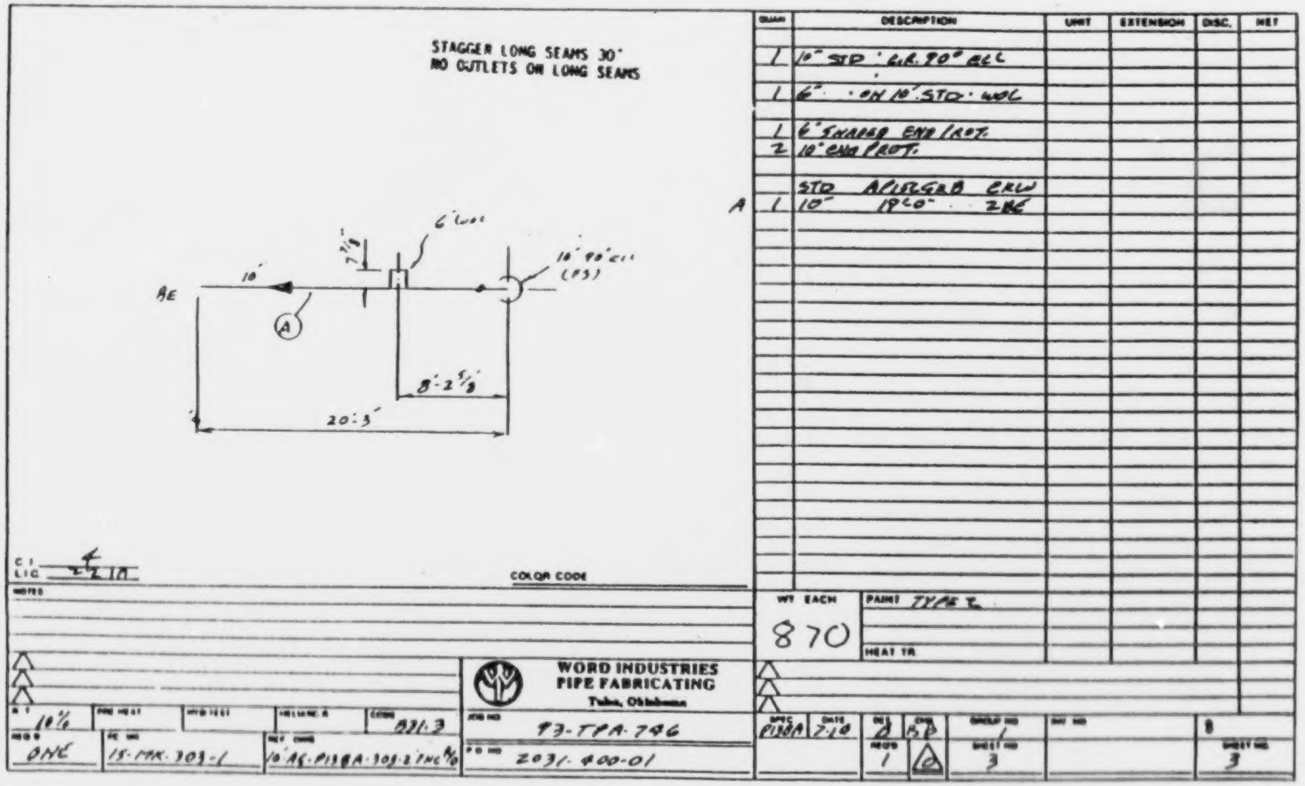
WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

10%
YES
CODE B31.3
JOB NO 93-TPA-746-D2
ONE
16"-MK-334-E
3"-0-P228-334-2 4/0
P.O. NO 2031-400-01
P23B
7-18
B
BB
GROUP NO 1
1
0
SHEET NO 8
S
SHEET NO 8

Answers to Assignment Sheets

Assignment Sheet 4

Spool 1 from Isometric B



STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS

	QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	1	10" STD · L.R. 90° ELL				
	1	6" · ON 10" STD · WOL				
	1	6" SHAPED END PROT.				
	2	10" END PROT.				
		STD API5LGRB ERW				
A	1	10" 19'-0" 2BE				

C I 4
LIG 2 2 IR
COLOR CODE
NOTES

WT EACH 870
PAINT TYPE I
HEAT TR

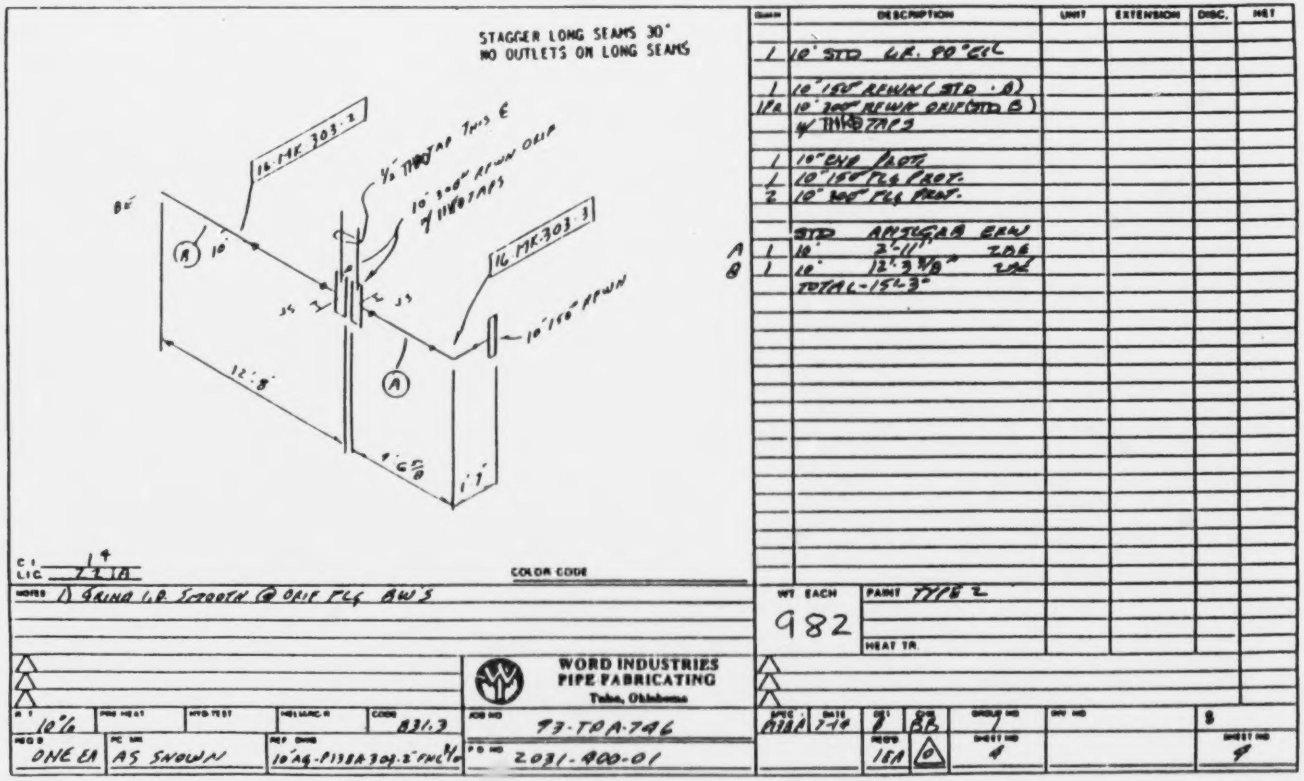
WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

X-RAY 10%
CODE B31.3
REQ'D ONE
PC NO 15-MK-303-1
REF DWG 10"AC-P15BA-303-2"INC'D
JOB NO 93-TPA-746
P O NO 2031-400-01
SPEC P15BA
DATE 7-10
DR D
CHK BP
GROUP NO 1
REQ'D 1
SHEET NO 3
SHEET NO 3

Answers to Assignment Sheets

Assignment Sheet 4

Spool 2 from Isometric B


STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS
16-MK-303-2
1/2" THRD TAP THIS ℄
10" 300# RFWN ORIF
W/ THRD TAPS
16-MK-303-3
10" 150# RFWN
BE
Ⓐ
10"
Ⓐ
12'-8"
4'-6 5/8"
1'-7"

	QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	1	10" STD W.E. 90° ELL				
	1	10" 150# RFWN (STD · B)				
	1PR	10" 300# RFWN ORIF (STD B)				
		w/ THRD TAPS				
	1	10" END PROT.				
	1	10" 150# FLG PROT.				
	2	10" 300# FLG PROT.				
		STD ANSI GR B ERW				
A	1	10" 2'-11" 2A6				
B	1	10" 12'-3 7/8" 2A6				
		TOTAL-15'-3"				

C.I. 14
L.I.C. 7.2.1A

COLOR CODE

NOTES 1) GRIND I.D. SMOOTH @ ORIF FLG. BW'S

WT EACH 982

PAINT TYPE 2

HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

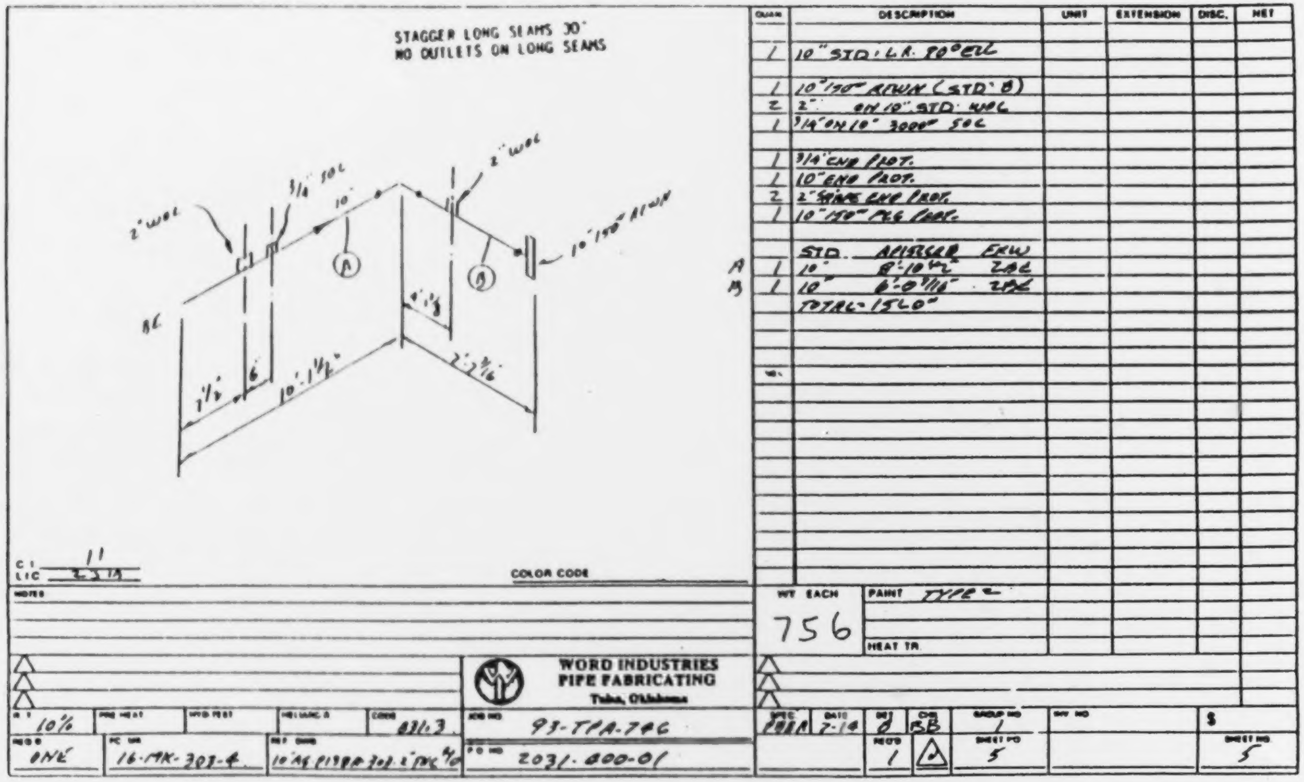
R.T. 10%	PWH HEAT	HYD TEST	HELIARC R	CODE B31.3	JOB NO 73-TPA-746
REQ'D ONE EA	PC MK AS SHOWN	REF DWG 10"AG-P138A 303.2" FNC 1/10			P.O. NO 2031-400-01

SPEC M18A	DATE 7-14	DR 8	CHK BB	GROUP NO 7	DWG NO	S
		REV'D 1EA	△0	SHEET NO 4		SHEET NO 9

Answers to Assignment Sheet

Assignment Sheet 4

Spool 3 from Isometric B


STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS
2" WOL
3/4" SOL
10"
A
2" WOL
B
10" 150# RFWN
BC
7½"
6
10'-1½"
4'-1½"
2'-2 3/16"

	QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	1	10" STD. L.R. 90° ELL				
	1	10" 150# RFWN (STD. B)				
	2	2" ON 10" STD. WOL				
	1	3/4" ON 10" 3000# SOL				
	1	3/4" END PROT.				
	1	10" END PROT.				
	2	2" SHAPE END PROT.				
	1	10" 150# FLG PROT.				
		STD. A155GRB EFW				
A	1	10" 8'-10½" 2AC				
B	1	10" 6'-0 11/16" 2AC				
		TOTAL-15'-0"				

C.I. 11
LIC 2.3.13

COLOR CODE

NOTES

WT EACH 756

PAINT TYPE 2

HEAT TR.

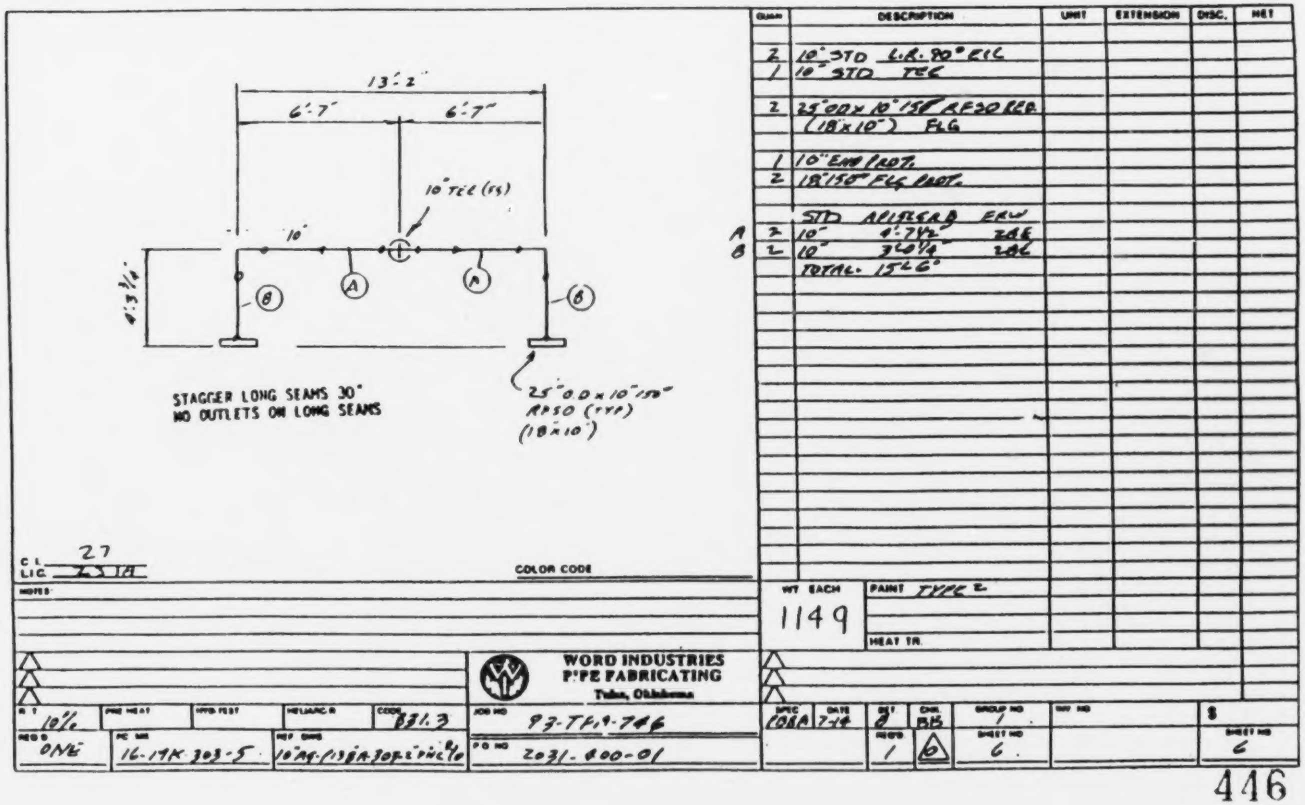
WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

R.T. 10%	PRE HEAT	HYD TEST	HELIARC'D	CODE B31.3	JOB NO 93-TPA-746	SPEC P88A	DATE 7-14	DFT D	CHK BB	GROUP NO 1	SHT NO
REQ'D ONE	PC NO 16-MK-303-4	REF DWG 10"AG P1388-303-2"PXC 4/10			P.O. NO 2031-000-01			REV'D 1	△	SHEET PO 5	SHEET NO 5

Answers to Assignment Sheets

Assignment Sheet 4

Spool 4 from Isometric B


13'-2"
6'-7"
6'-7"
10" TEE (FS)
10"
4'-3 3/4"
Ⓑ
Ⓐ
Ⓐ
Ⓑ
STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS
25" O.D × 10" 150#
RFSO (TYP)
(18" × 10")
C.L. 27
LIC. 2.3 1A
COLOR CODE
NOTES:
WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

	QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	2	10" STD L.R. 90° ELL				
	1	10" STD TEE				
	2	25" OD × 10" 150# RFSO RED.				
		(18" × 10") FLG				
	1	10" END PROT.				
	2	18" 150# FLG PROT.				
		STD API 5L GR B ERW				
A	2	10" 4'-7 1/2" 2BE				
B	2	10" 3'-0 1/4" 2BE				
		TOTAL 15'-6"				

WT EACH 1149
PAINT TYPE 2
HEAT TR.

X-RAY 10%	PRE HEAT	HYDRO TEST	HELIARC'D	CODE B31.3
REQ'D ONE	PC NO 16-14K 303-5	REF DWG 10"AG-1138A-30F2"PNC 4/10		

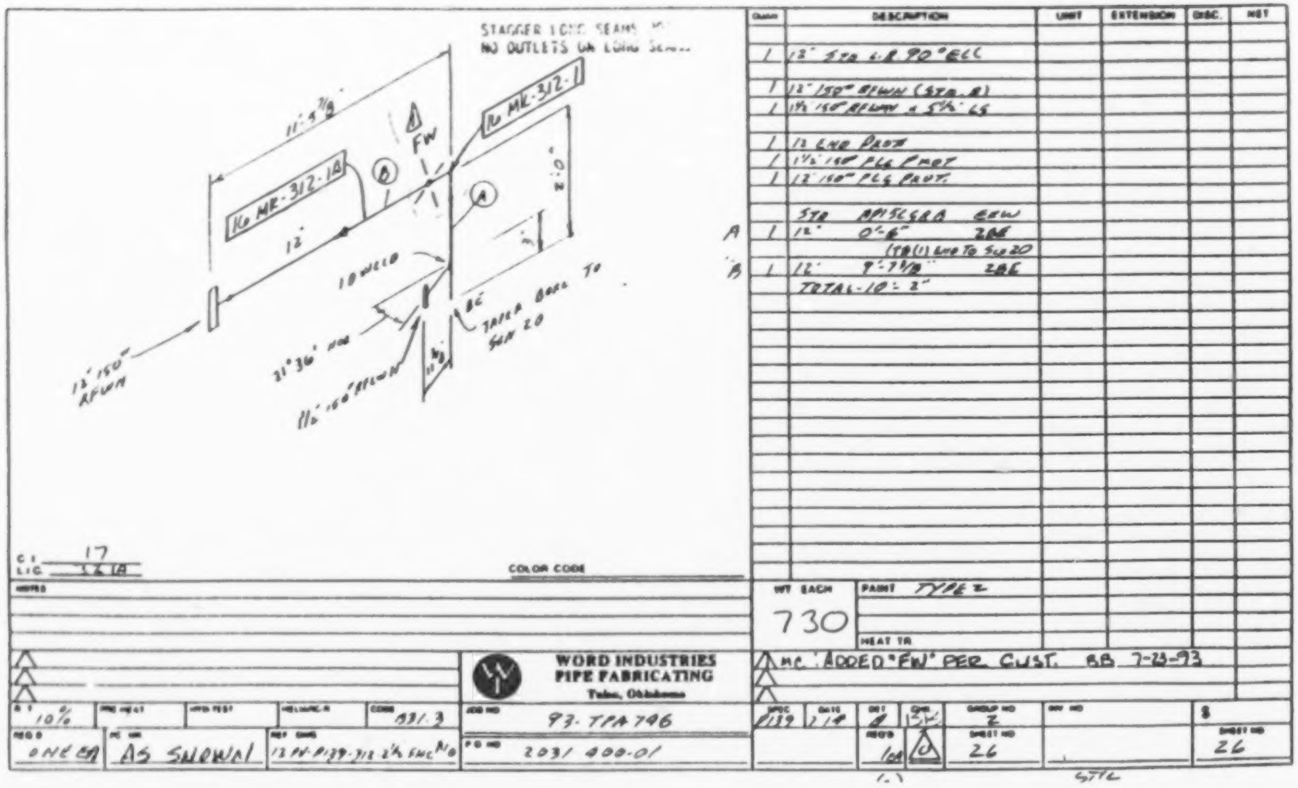
JOB NO 93-TF19-746
P.O. NO 2031-400-01

SPEC	DATE	DET	CHK	GROUP NO	DWG NO	$
1OBA	7-14	D	BB	1		
		REQ'D 1	⑥	SHEET NO 6		SHEET NO 6

Answers to Assignment Sheets

Assignment Sheet 5

Spool 1 from Isometric C


STAGGER LONG SEAMS
NO OUTLETS ON LONG SEAM
11'-5 7/8"
FW
16 MR-312-1
16 MR-312-1A
B
A
2'-0"
12"
10 WELD
12" 150# RFWN
21°36' HOR
1 1/2" 150# RFWN
BC
TAPER BORE TO SCH 20
11 7/8"
3"

QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
1	12" STD L.R. 90° ELL				
1	12" 150# RFWN (STD. B)				
1	1½" 150# RFWN x 5½" LS				
1	12 END PROT				
1	1½" 150# FLG PROT				
1	12" 150# FLG PROT.				
	STD API5LGRB ERW				
A 1	12" 0'-6" 2BE				
	(TB(1) END TO SCH 20				
B 1	12" 9'-7 3/8" 2BE				
	TOTAL-10'-2"				

C.I. 17
L.C. 3-6 1A

COLOR CODE

NOTES

WT EACH 730

PAINT TYPE Z

HEAT TR

△ MC "ADDED "FW" PER CUST. BB 7-23-93

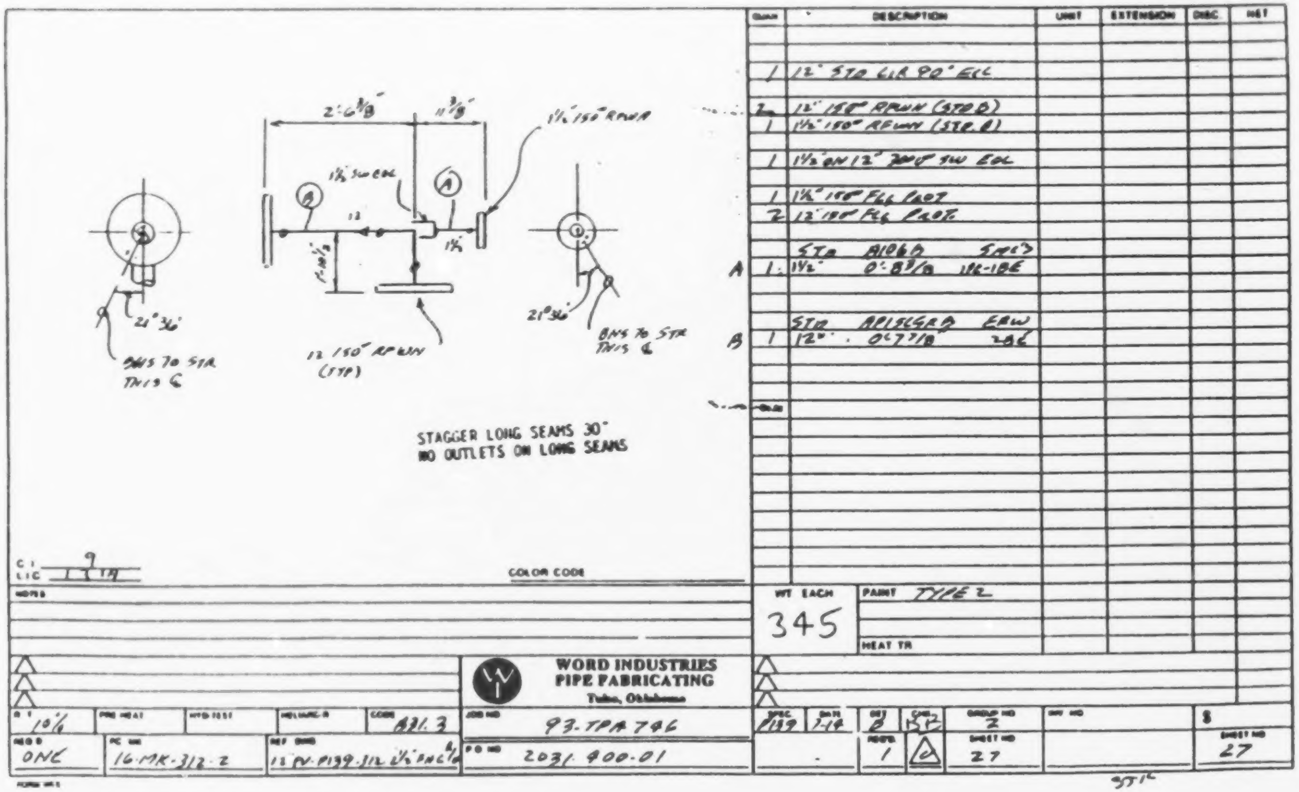
WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

X-RAY 10%
PRE HEAT
HYDRO TEST
HELIARC-R
CODE B31.3
JOB NO 93-TPA796
SPEC P139
DATE 2-14
DET Ø
CHK ISK
GROUP NO Z
DRW NO
REQ'D ONE EA
PC NO AS SHOWN
REF DWG 13 M-P139-312 2⅝ SHC NO
P.O. NO 2031 400-01
REQ'D 1 EA
SHEET NO 26
SHEET NO 26

Answers to Assignment Sheet

Assignment Sheet 5

Spool 2 from Isometric C


2'-6 3/8"
11 3/8"
1½" 150# RFWN
1½" SW EOL
B
A
12
1½"
21°36'
BHS TO STR THIS ℄
12 150# RFWN (TYP)
21°36'
BHS TO STR THIS ℄

STAGGER LONG SEAMS 30°
NO OUTLETS ON LONG SEAMS

	QUAN	DESCRIPTION	UNIT	EXTENSION	DISC.	NET
	1	12" STD LR 90° ELL				
	2	12" 150# RFWN (STD B)				
	1	1½" 150# RFWN (STD B)				
	1	1½" ON 12" 3000# SW EOL				
	1	1½" 150# FLG PROT				
	2	12" 150# FLG PROT				
		STD A106B SMLS				
A	1	1½" 0'-8 3/8 1PC-1BE				
		STD API5LGRB ERW				
B	1	12" 0'-7 7/8 2BE				

C.I. 9
COLOR CODE
NOTES

WT EACH 345
PAINT TYPE 2
HEAT TR

WORD INDUSTRIES
PIPE FABRICATING
Tulsa, Oklahoma

X-RAY 10%
PRE HEAT
HYD TEST
CODE B31.3
JOB NO 93-TPA 746
SPEC P139
DATE 7-14
GROUP NO 2
DWG NO
REQ'D ONE
PC MK 16-MK-312-2
REF DWG 12 PV-P139-312 1½" PNC
P.O. NO 2031 400-01
REQ'D 1
SHEET NO 27
SHEET NO 27

Isometric
Unit 6

Answers to Written Test

1.

a.	5	e.	3	i.	8
b.	11	f.	9	j.	4
c.	10	g.	1	k.	2
d.	7	h.	12	l.	6

2. a, b, c, e

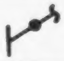
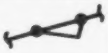
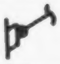
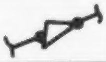
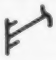
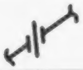
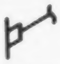
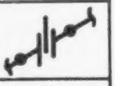
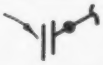
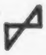
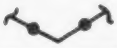
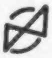
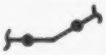
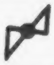
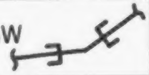
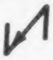
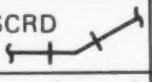
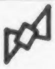
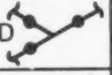
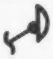
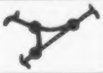
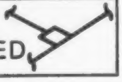
3. a. Connecting line number
   b. Centerline elevation
   c. Pipe size
   d. Instrumentation balloon
   e. North arrow
   f. Centerline to centerline dimension
   g. Shop weld
   h. Field weld
   i. Centerline to face dimension
   j. Erection mark (spool mark)
   k. Special fitting balloon
   l. Equipment item number and title

4. Any six of the following

   a. Line number
   b. Stress relieving notation
   c. X-ray notation
   d. Hydrostatic testing pressure
   e. Insulation thickness
   f. Design pressure
   g. Operating pressure
   h. Design temperature
   i. Operating temperature
   j. Pipe length, specs, and grade
   k. Flange, fitting, and valve quanities, sizes, ratings, types, and materials
   l. Bolt and gasket diameters, sizes, lengths, and materials
   m. General notes

Answers to Written Test

5.

Fitting	Symbol	Fitting	Symbol
FLANGE, WN		RED, ECC	
FLANGE, SO		SWAGE	
FLANGE, SW		UNION	
FLANGE, SCRD		ORIFICE, FLGD	
FLANGE, BLD		GATE VA	
ELBOW, 90°		BALL VA	
ELBOW, 45°		GLOBE VA	
ELBOW, 45° SW		CHECK VA	
ELBOW, 45° SCRD		PLUG VA	
TEE, BUTT WELD		CAP, WELDED	
TEE, RED		CPLG, THREADED	

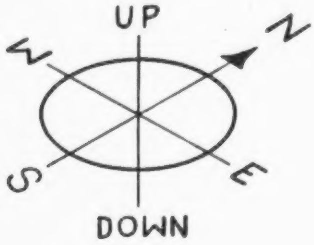
6. c, f

7. b, c, e, h, j, k

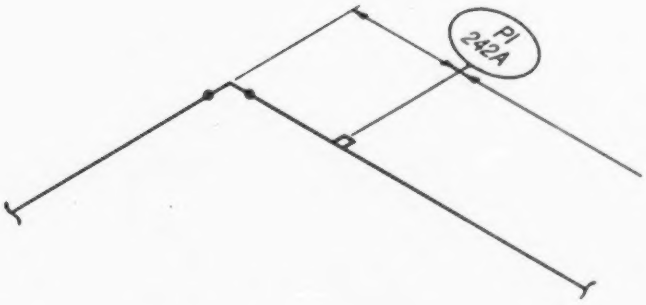
8. a, b, c

Answers to Written Test

9. Preferred method should show the N arrow to the upper right. Arrow must be on the drawing side, but placement may vary.



10.



11. a. Spools
    b. Open
    c. Hidden lines
    d. Pipes
    e. Do not

12. a. (3)
    b. (2)

13. None of the statements are true.

14. a. Other pieces of pipe
    b. Smaller
    c. Elbow

Isometrics
Unit 6

Written Test

Name ______________________________ Date ____________ Score ________

1. Match the terms on the right with their correct definitions.

_____a. The right or lower area of an isometric/spool drawing where a BOM (Bill of Material) is positioned

_____b. The left or upper area of an isometric/spool drawing where the drawings itself is positioned

_____c. Bracing usually made of pipe and pipe components designed to carry weight and add support to pipe lines, but does not contact or affect flow

_____d. The joining of two pieces of metal by welding on site by a construction crew

_____e. Pressurizing water inside fabricated pipe spools to quality check the assembly

_____f. A drawing that usually shows an entire line from one vessel to another, and is used by a drafter to construct a spool drawing

_____g. A mark used to identify items and track fabricated pipe assemblies from engineering to shop, to painting, to testing, to job site, and to final assembly

_____h. The joining of two pieces of metal by welding in a fabrication shop

_____i. A drawing used by fabrication shops to completely detail one part of a line of pipe; it contains all necessary dimensions, components, and fabrication notes

1. Mark number
2. Tallying
3. Hydrostatic testing
4. Stress relieving
5. BOM side
6. X-ray testing
7. Field weld
8. Spool drawing
9. Isometric drawing
10. Dummy support
11. Drawing side
12. Shop weld

Written Text

______j. The use of heat to reduce the stress in pipe and pipe components; usually done after all welding has been completed on a spool

______k. Calculating the total number of components, and length and weight of pipe and components

______l. The use of a special photo to examine and document the penetration and porosity of a weld

2. Select true statements about purposes of isometric and spool drawings. Place an "X" beside each true statement.

______a. For detailing and dimensioning piping systems

______b. For ordering final talley parts

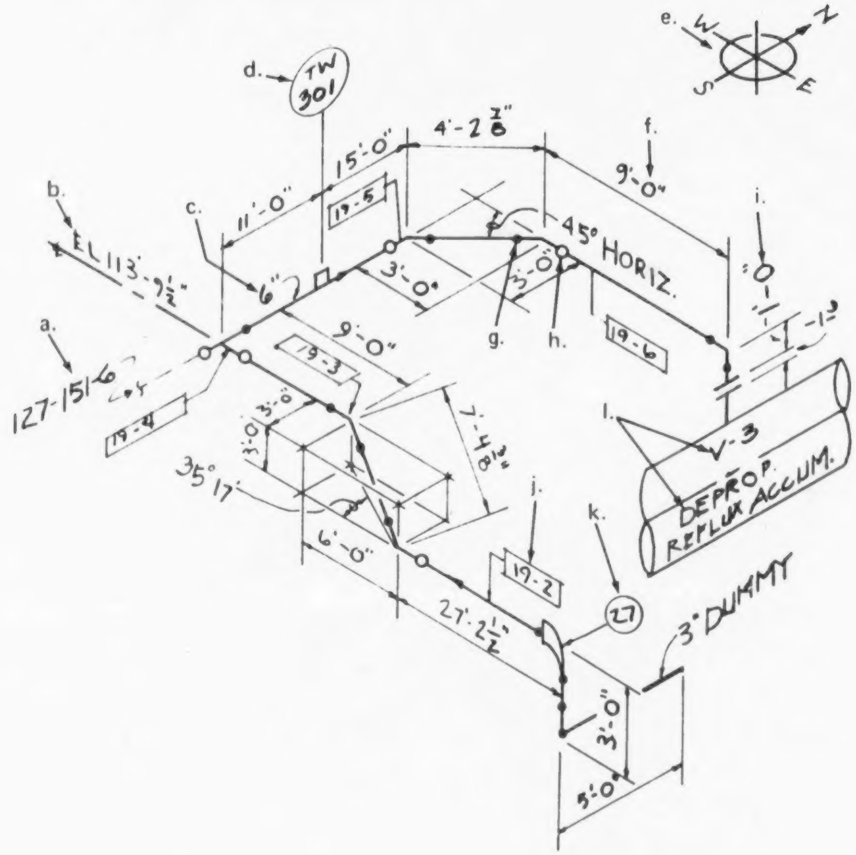
______c. For flagging and detailing special pipe components

______d. For shop reference

______e. For installation in the field by construction crews

Written Test

3. Identify information on the drawing side of an isometric. Write the correct information in the appropriate blank.


e.
W
N
S
E
d.
TW 301
f.
4'-2 7/8"
15'-0"
9'-0"
b.
c.
11'-0"
19-5
i.
EL 113'-9 1/2"
6"
3'-0"
45° HORIZ.
3'-0"
a.
9'-0"
g.
h.
19-6
-1 3/4
127-151-6"
19-3
19-4
3'-0"
3'-0"
7'-4 13/16"
l.
V-3
DEPROP. REFLUX ACCUM.
35° 17'
j.
k.
6'-0"
19-2
27'-2 1/2"
27
3" DUMMY
3'-0"
5'-0"

a. ______________________ b. ______________________

c. ______________________ d. ______________________

e. ______________________ f. ______________________

g. ______________________ h. ______________________

i. ______________________ j. ______________________

k. ______________________ l. ______________________

Written Test

4. List six types of information on a bill of material. Items may appear in any order.

   a. ______________________________

   b. ______________________________

   c. ______________________________

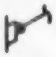
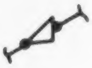
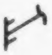
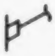
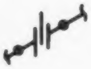
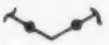
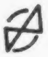
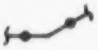
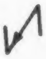
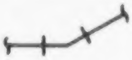
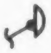
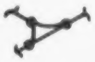
   d. ______________________________

   e. ______________________________

   f. ______________________________

Written Test

5. Complete the following chart of single line isometric symbols. Enter the fitting name or sketch the sumbol as indicated.

Fitting	Symbol	Fitting	Symbol
FLANGE, WN	a. __________	RED, ECC	b. __________
c. __________		SWAGE	
FLANGE, SW		UNION	d. __________
FLANGE, SCRD		ORIFICE, FLGD	
FLANGE, BLD	e. __________	f. __________	
g. __________		h. __________	
ELBOW, 45°		GLOBE VA	i. __________
ELBOW, 45° SW	j. __________	CHECK VA	
ELBOW, 45° SCRD		PLUG VA	k. __________
TEE, BUTT WELD	l. __________	CAP, WELDED	
m. __________		CPLG, THREADED	n. __________

Written Test

6. Select true statements about isometric fitting representation. Place an "X" beside each true statement.

   ______a. There are two main planes in isometric drawing.

   ______b. Each fitting has two main representations in each plane.

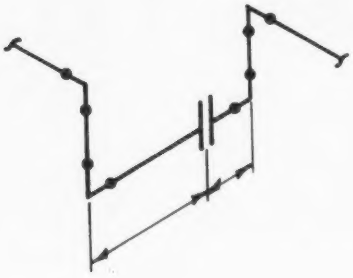
   ______c. There can be an infinite number of supplementary planes.

   ______d. Fittings are drawn to scale.

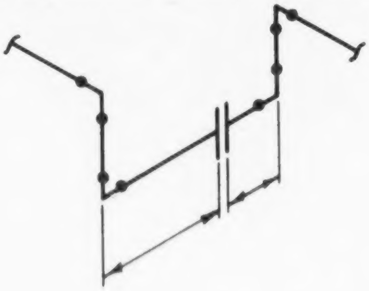
   ______e. If a fitting is drawn on a drawing more than once, the size should be changed.

   ______f. If a special fitting has no symbol, a new symbol should be drawn and noted in the legend.

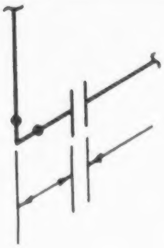
7. Differentiate between correct and incorrect procedures for dimensioning isometrics. Place an "X" below each graphic that depicts the correct procedure.



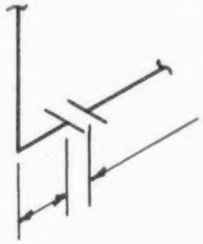
a. ____________________



b. ____________________

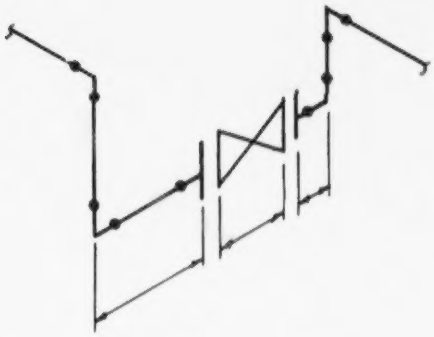


c. ____________________

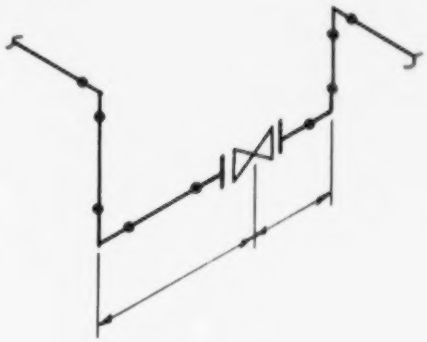


d. ____________________

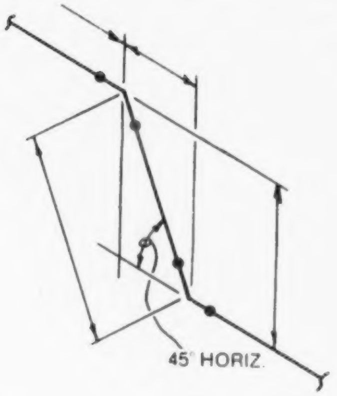
Written Test



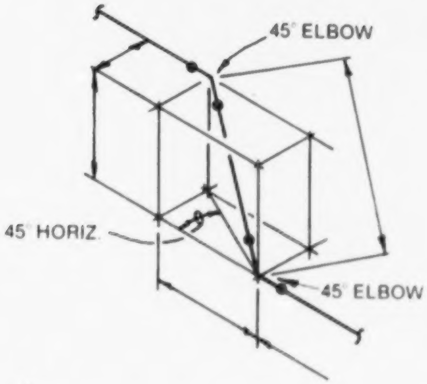
e. ______________________



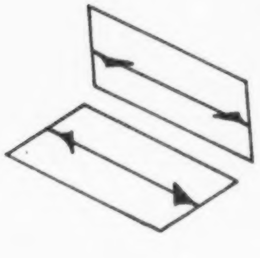
f. ______________________



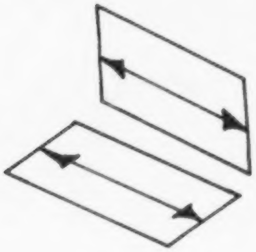
g. ______________________


45° ELBOW
45° HORIZ.
45° ELBOW

h. ______________________

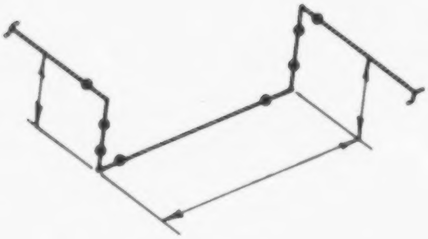


i. ______________________

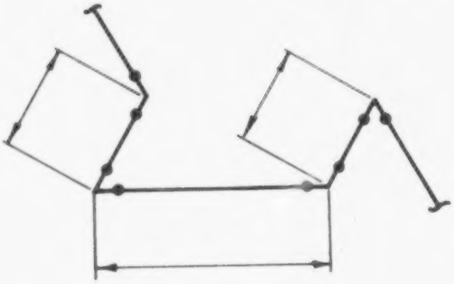


j. ______________________

Written Test



k. ______________________



l. ______________________

8. Select true statements about guidelines for dimensioning angle and rolled offsets. Place an "X" beside each true statement.

_____a. Dimension angle offsets to show vertical distances in the correct planes.

_____b. Show horizontal distance for angle offsets in the correct plane.

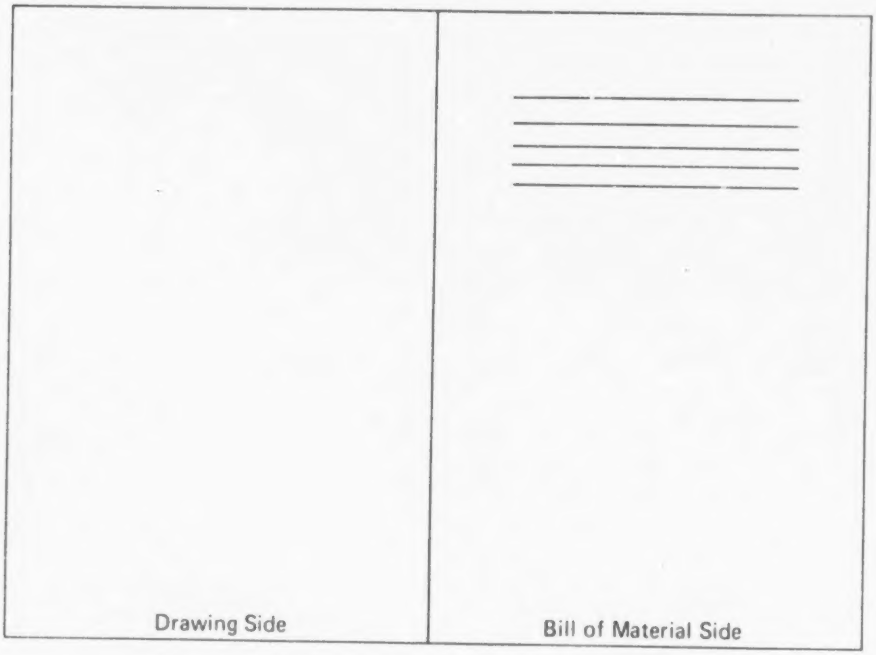
_____c. Indicate length of pipe and angular measurement for angle offsets.

_____d. Dimension rolled offsets to show only vertical distances.

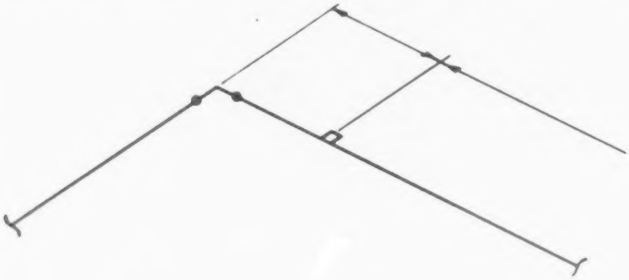
_____e. Show rolled offset width dimensions as well as length of pipe and angular measurement.

Written Test

9. Draw and correctly place a north arrow using the preferred method on the imaginary sheet of drawing paper below.


Drawing Side
Bill of Material Side

10. Draw and letter an instrumentation balloom for a pressure indicator, number 242A, on the appropriate line below.



Written Test

11. Complete statements about drawing connecting lines and numbers. Circle the materials that best completes each of the following statements.

    a. Call out connecting lines in full to clarify the beginning and ending of continuing (**lines**) (**spools**).

    b. To indicate a field weld, draw an (**open**) (**closed**) dot where the line connects to another line.

    c. Draw connecting lines as (**cutting plane lines**) (**hidden lines**).

    d. Break connecting lines only on (**pipes**) (**turns**), never on fittings or valves.

    e. (**Do**) (**Do not**) dimension connecting lines.

12. Solve problems about guidelines for drawing and placing vents and drains. Circle the number of the best answer to each of the following situations.

    a. You've been informed by the head drafter that a line is going to be pressure tested with air after it is fabricated in the field. You know that in the drawing you should look for:

        (1) A statement about testing

        (2) A symbol for testing

        (3) A place to put a vent coupling at a high point in the line

    b. You see a drain coupling called for, and it appears to be at a high point in a line. You should:

        (1) Know that the drain is going to be used to let water out of the line.

        (2) Inform the head drafter that something is wrong with specifications because drain couplings are placed only at low points in a line.

        (3) Change the plans as you see fit.

Written Test

13. Select true statements about guidelines for drawing and placing shop and field erection marks. Place an "X" beside each true statement.

_______a. Use mark numbers to reference different isometrics.

_______b. Construct mark numbers with two numbers—the first number is the line number, and the second number is the drawing number.

_______c. Place mark numbers on the isometric in round circles with leader lines.

14. Complete statements about guidelines for noting and drawing dummy supports. Circle the information that best completes each of the following statements.

a. Make dummy supports from pieces of pipe welded to (**any crossmember**) (**other pieces of pipe**), and use them in stress areas where piping needs extra support.

b. Make dummy supports from pipe one size (**smaller**) (**larger**) than the pipe they are supporting.

c. Dimension dummy supports from the centerline of the (**face**) (**elbow**) to the end of the dummy.

*Permission to duplicate this test is granted.

Isometrics
Unit 6

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Fill Out a BOM and Calculate Lengths of pipe, Part A Rating ______

Comments: ______________________________

____

Assignment Sheet 2—Fill out a BOM and Calculate Lengths of Pipe, Part B Rating ______

Comments: ______________________________

____

Assignment Sheet 3—Draw a Spool Drawing From Isometric A Rating ______

Comments: ______________________________

____

Assignment Sheet 4—Draw a Spool Drawing From Isometric B Rating ______

Comments: ______________________________

____

Assignment Sheet 5—Draw a Spool Drawing From Isometric C Rating ______

Comments: ______________________________

____

Unit Evaluation Form

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ____

____

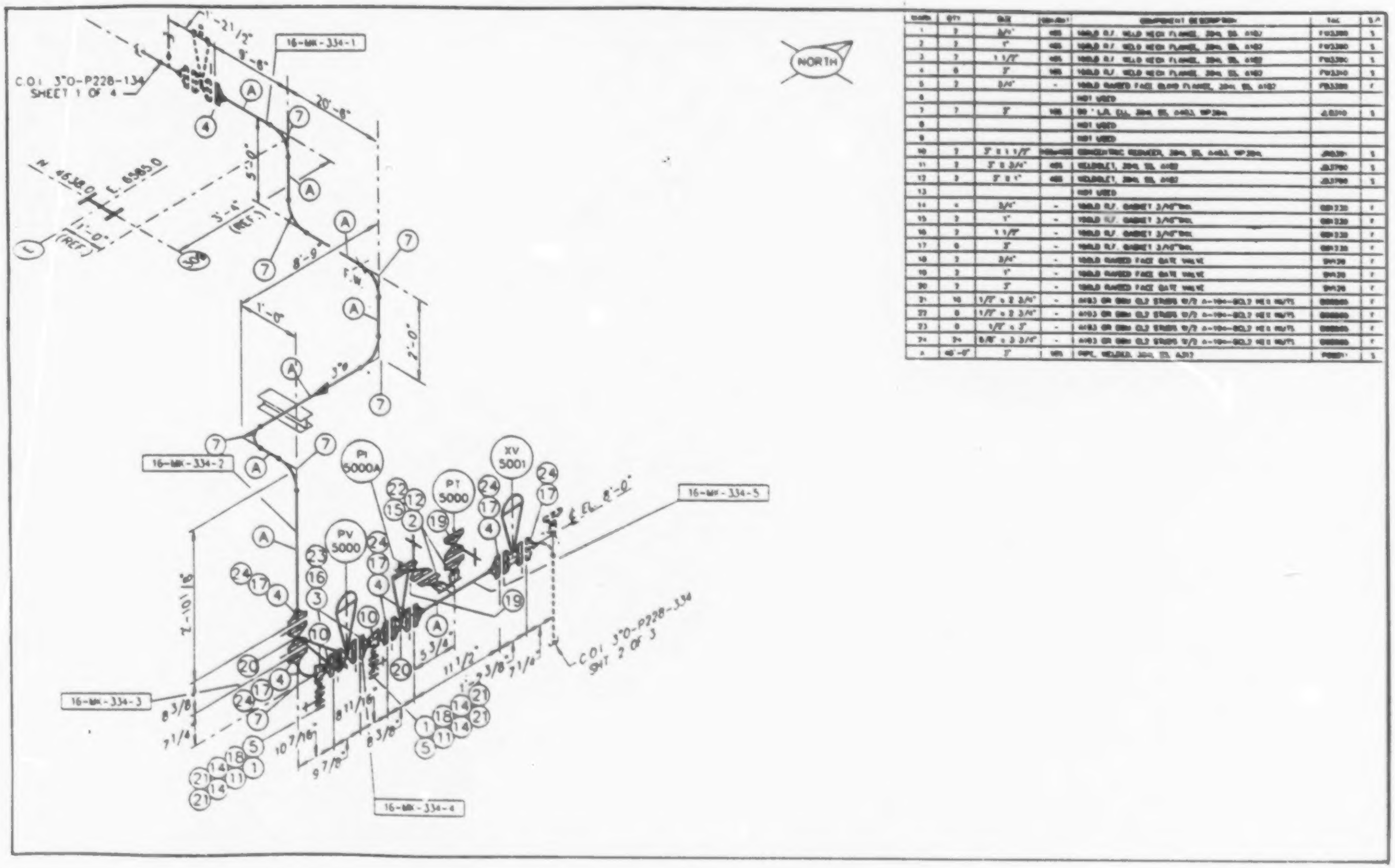
Teacher Signature ____________________________ Date ____________

Student Signature ____________________________ Date ____________

466

*Permission to duplicate this form is granted.

Piping Isometric

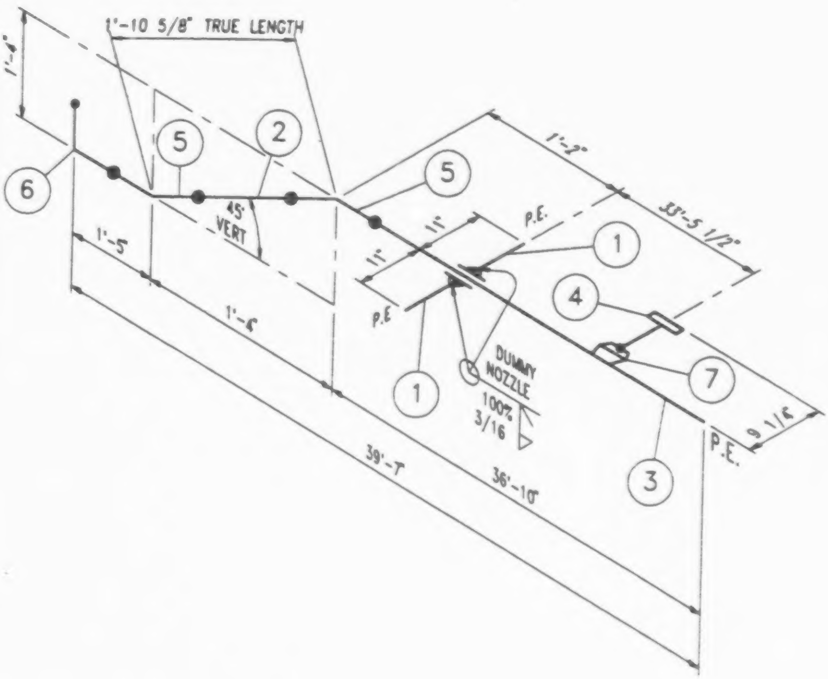


16-WM-334-1
C.O.I. 3"Ø-P228-134
SHEET 1 OF 4
NORTH
1'-2 1/2"
9'-8"
20'-8"
5'-0"
3'-6" (REF.)
N 46380
E 65850
1'-0" (REF.)
8'-9"
F.W.
1'-0"
2'-0"
3"Ø
16-WM-334-2
PI 5000A
PV 5000
PT 5000
XV 5001
16-WM-334-5
℄ EL. 8'-0"
2'-10 1/8"
16-WM-334-3
8 3/8
7 1/4
10 7/16
9 7/8
8 11/16
8 3/8
3 3/4
11 1/2
1'-9 3/8
7 1/2
C.O.I. 3"Ø-P228-334
SHT 2 OF 3
16-WM-334-4

BEST COPY AVAILABLE

Spool Drawing

USE WELD PROCEDURES: 1-M-1(ER70S-6) OR 1-TM-1(ER70S-6) OR 1-TS-1(ER70S-6/E7018)


1'-4"
1'-10 5/8" TRUE LENGTH
⑤
②
⑥
45° VERT
1'-5"
1'-6"
1'-2"
⑤
P.E.
①
33'-5 1/2"
④
P.E
DUMMY NOZZLE
100%
3/16
①
⑦
9 1/6
P.E.
③
39'-7"
36'-10"

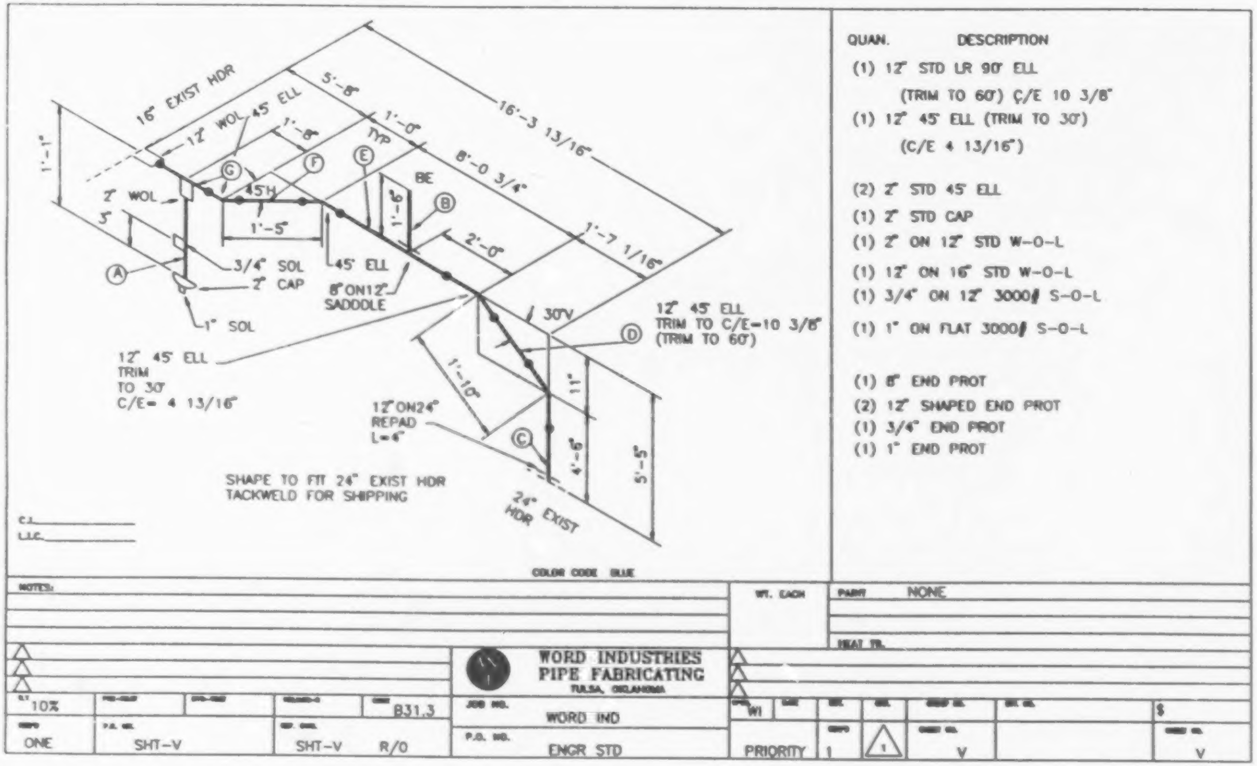
ITEM	QTY.		DESCRIPTION	
7	1	WELDOLET	3" SCH 40 ON 8" BW	A105
6	1	ELBOW	8" SCH 20 90 LR BW	A234-WPB
5	2	ELBOW	8" SCH 20 45 LR BW	A234-WPB
4	1	FLANGE	3" 300# RF WN SCH 40	A105
3	1	PIPE	8" SCH 20 X 36'-5" LG. (BE-PE)	A53-Gr. B
2	1	PIPE	8" SCH 20 X 1'-0 5/8" LG. (BBE)	A53-Gr. B
1	2	PIPE	6" SCH 40 X 7 15/16" LG. (PE-NOZ)	A53-Gr. B

REV 1			REV 2		
REV 3			REV 4		
NONE	10% BW	NONE	NONE	YES	ANSI B31.3
HYDROTEST	RADIOGRAPHY	HEAT TREAT	MAG. CHECK	PT	CODE
DWG. REF B-1213 SHT.2	CUST. SPEC.		DWN. CBG	CHK. WW	DATE 6-16-93
DESCRIPTION SPOOL				MK. NO. 1213-J31C-2-B	
CUSTOMER TEXACO REFINING AND MARKETING INC.			QTY. ONE	S.O. NO. 1080-A1	DWG. NO. 3 REV. 0

piping companies inc.
Box 190, Sand Springs, OK 74063
Telephone (918) 245-6606

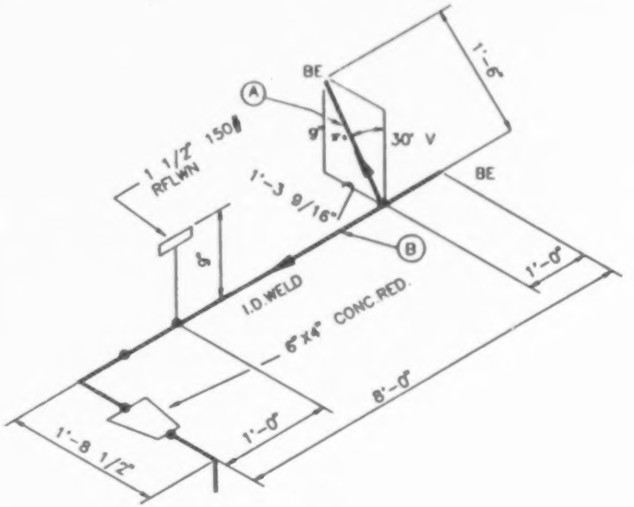
Spool Drawing

(Continued)


16" EXIST HDR
12" WOL
45° ELL
5'-8"
16'-3 13/16"
1'-0" TYP
1'-8"
8'-0 3/4"
1'-1"
G
F
E
BE
B
2" WOL
45°H
1'-5"
1'-6"
5"
2'-0"
1'-7 1/16"
A
3/4" SOL
2" CAP
45° ELL
8" ON12" SADDLE
1" SOL
30°V
D
12" 45° ELL TRIM TO C/E=10 3/8" (TRIM TO 60°)
12" 45° ELL TRIM TO 30° C/E= 4 13/16"
1'-10"
11"
12" ON24" REPAD L=4"
C
4'-6"
5'-5"
SHAPE TO FIT 24" EXIST HDR TACKWELD FOR SHIPPING
24" EXIST HDR
C.I.
L.I.C.
COLOR CODE BLUE
NOTES:
WT. EACH
PAINT NONE
HEAT TR.
WORD INDUSTRIES PIPE FABRICATING TULSA, OKLAHOMA
10%
B31.3
JOB NO. WORD IND
ONE
SHT-V
SHT-V R/0
P.O. NO. ENGR STD
WI
PRIORITY 1
1
V
$
V

QUAN.	DESCRIPTION
(1)	12" STD LR 90° ELL (TRIM TO 60°) C/E 10 3/8"
(1)	12" 45° ELL (TRIM TO 30°) (C/E 4 13/16")
(2)	2" STD 45° ELL
(1)	2" STD CAP
(1)	2" ON 12" STD W-O-L
(1)	12" ON 16" STD W-O-L
(1)	3/4" ON 12" 3000# S-O-L
(1)	1" ON FLAT 3000# S-O-L
(1)	8" END PROT
(2)	12" SHAPED END PROT
(1)	3/4" END PROT
(1)	1" END PROT

Spool Drawing
(Continued)


BE
1'-6"
Ⓐ
9"
30° V
1 1/2" 150#
RFLWN
1'-3 9/16"
BE
8"
Ⓑ
I.D.WELD
6"X4" CONC.RED.
1'-0"
8'-0"
1'-0"
1'-8 1/2"

QUAN.	DESCRIPTION
(1)	4" STD LR.90° ELL
(1)	6" STD L.R. 90° ELL
(1)	6"X4" STD CONC.RED.
(1)	1 1/2" 150# RFLWN (6 1/4" LG).
(2)	4" END PROT
(1)	6" END PROT
(1)	1 1/2" 150# FLG PROT

STD A106-B SMLS

A (1) 4" 1'-3 3/8" PE/BE

B (1) 6" 7'-3" 2BE

C.I.

L.I.C.

COLOR CODE BLUE

NOTES:

WT. EACH

PAINT NONE

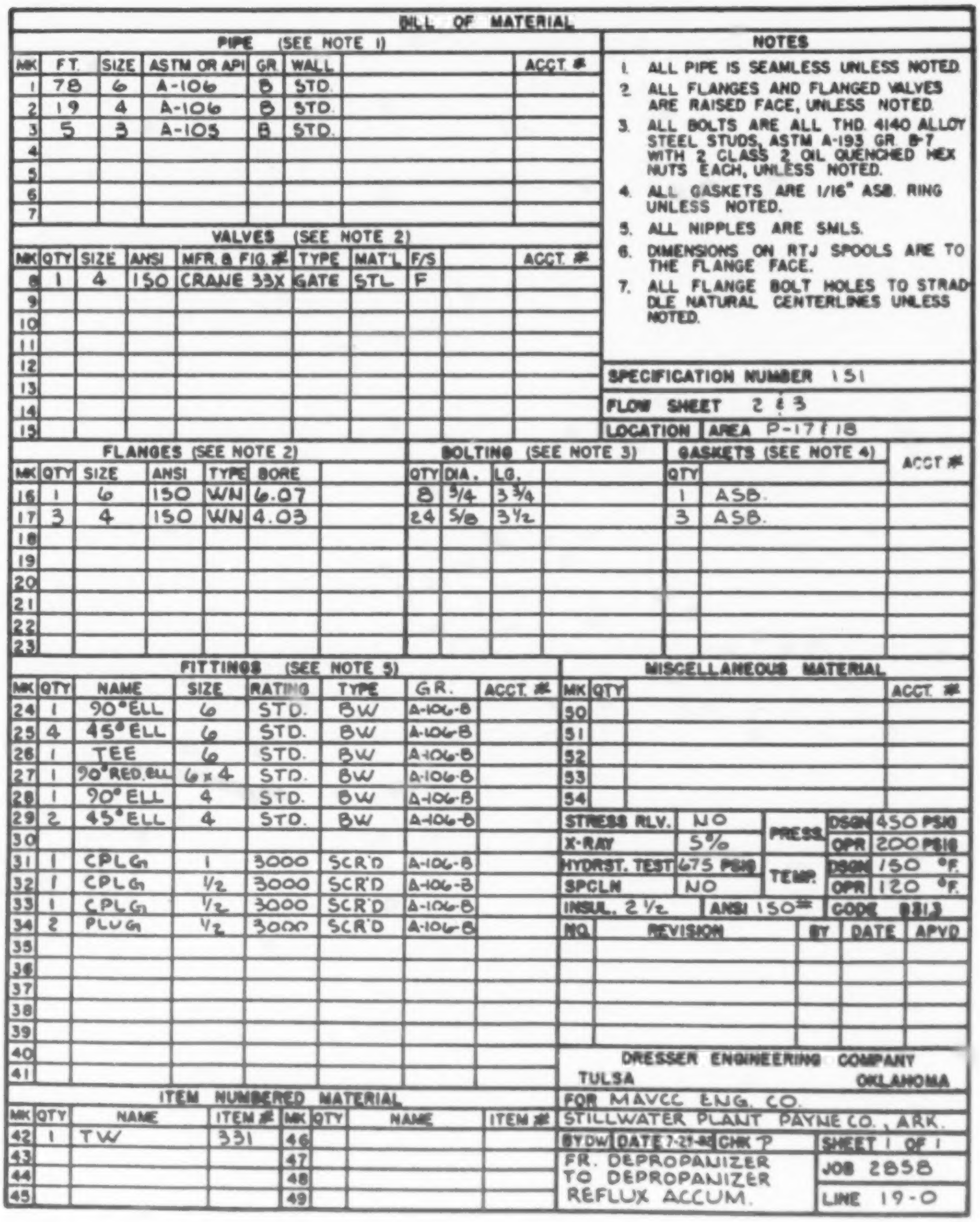
HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA

10%				B31.3	JOB NO. WORD IND
ONE	SHT-L		SHT-L R/0		P.O. NO. ENGR STD

WI						$
PRIORITY		1	△0	L		L

Bill of Material



BILL OF MATERIAL

PIPE (SEE NOTE 1)

MK	FT.	SIZE	ASTM OR API	GR.	WALL		ACCT #
1	78	6	A-106	B	STD.		
2	19	4	A-106	B	STD.		
3	5	3	A-105	B	STD.		
4							
5							
6							
7							

VALVES (SEE NOTE 2)

MK	QTY	SIZE	ANSI	MFR. & FIG. #	TYPE	MAT'L	F/S		ACCT. #
8	1	4	150	CRANE 33X	GATE	STL	F		
9									
10									
11									
12									
13									
14									
15									

NOTES

1. ALL PIPE IS SEAMLESS UNLESS NOTED.
2. ALL FLANGES AND FLANGED VALVES ARE RAISED FACE, UNLESS NOTED.
3. ALL BOLTS ARE ALL THD. 4140 ALLOY STEEL STUDS, ASTM A-193 GR. B-7 WITH 2 CLASS 2 OIL QUENCHED HEX NUTS EACH, UNLESS NOTED.
4. ALL GASKETS ARE 1/16" ASB. RING UNLESS NOTED.
5. ALL NIPPLES ARE SMLS.
6. DIMENSIONS ON RTJ SPOOLS ARE TO THE FLANGE FACE.
7. ALL FLANGE BOLT HOLES TO STRADDLE NATURAL CENTERLINES UNLESS NOTED.

SPECIFICATION NUMBER 151

FLOW SHEET 2 & 3

LOCATION | AREA P-17 & 18

FLANGES (SEE NOTE 2)							BOLTING (SEE NOTE 3)				GASKETS (SEE NOTE 4)		ACCT #
MK	QTY	SIZE	ANSI	TYPE	BORE		QTY	DIA.	LG.		QTY		
16	1	6	150	WN	6.07		8	3/4	3 3/4		1	ASB.	
17	3	4	150	WN	4.03		24	5/8	3 1/2		3	ASB.	
18													
19													
20													
21													
22													
23													

FITTINGS (SEE NOTE 5)

MK	QTY	NAME	SIZE	RATING	TYPE	GR.	ACCT. #
24	1	90° ELL	6	STD.	BW	A-106-B	
25	4	45° ELL	6	STD.	BW	A-106-B	
26	1	TEE	6	STD.	BW	A-106-B	
27	1	90° RED. ELL	6 x 4	STD.	BW	A-106-B	
28	1	90° ELL	4	STD.	BW	A-106-B	
29	2	45° ELL	4	STD.	BW	A-106-B	
30							
31	1	CPLG	1	3000	SCR'D	A-106-B	
32	1	CPLG	1/2	3000	SCR'D	A-106-B	
33	1	CPLG	1/2	3000	SCR'D	A-106-B	
34	2	PLUG	1/2	3000	SCR'D	A-106-B	
35							
36							
37							
38							
39							
40							
41							

MISCELLANEOUS MATERIAL

MK	QTY		ACCT. #
50			
51			
52			
53			
54			

STRESS RLV.	NO	PRESS.	DSGN	450 PSIG
X-RAY	5%		OPR	200 PSIG
HYDRST. TEST	675 PSIG	TEMP.	DSGN	150 °F.
SPCLN	NO		OPR	120 °F.
INSUL. 2 1/2	ANSI 150#		CODE B31.3	

NO.	REVISION	BY	DATE	APVD

ITEM NUMBERED MATERIAL

MK	QTY	NAME	ITEM #	MK	QTY	NAME	ITEM #
42	1	TW	331	46			
43				47			
44				48			
45				49			

DRESSER ENGINEERING COMPANY
TULSA OKLAHOMA

FOR MAVCC ENG. CO.

STILLWATER PLANT PAYNE CO., ARK.

BY DW	DATE 7-21-85	CHK P	SHEET 1 OF 1

FR. DEPROPANIZER
TO DEPROPANIZER
REFLUX ACCUM.

JOB 2858

LINE 19-0

Isometrics
Unit 6

Information Sheet

1. **Terms and definitions**

   a. **BOM side** — The right or lower area of an isometric/spool drawing where a BOM (Bill of Material) is positioned

   b. **Drawing side** — The left or upper area of an isometric/spool drawing where the drawings itself is positioned

   c. **Drummy support** — Bracing usually made of pipe and pipe components designed to carry weight and add support to pipe lines, but does not contact or affect flow

   d. **Field weld** — The joining of two pieces of metal by welding on site by a construction crew

   e. **Hydrostatic testing** — Pressurizing water inside fabricated pipe spools to quality check the assembly

   f. **Isometric drawing** — A drawing that usually shows an entire line from one vessel to another, and is used by a drafter to construct a spool drawing

   g. **Mark number** — A mark used to identify items and track fabricated pipe assemblies from engineering to shop, to painting, to testing, to job site, and to final assembly

   h. **Shop weld** — The joining of two pieces of metal by welding in a fabrication shop

   i. **Spool drawing** — A drawing used by fabrication shops to completely detail one part of a line of pipe; it contains all necessary dimensions, components, and fabrication notes

   j. **Stress relieving** — The use of heat to reduce the stress in pipe and pipe components; usually done after all welding has been completed on a spool

   k. **Tallying** — Calculating the total number of components, and length and weight of pipe and components

   l. **X-ray testing** — The use of a special photo to examine and document the penetration and porosity of a weld

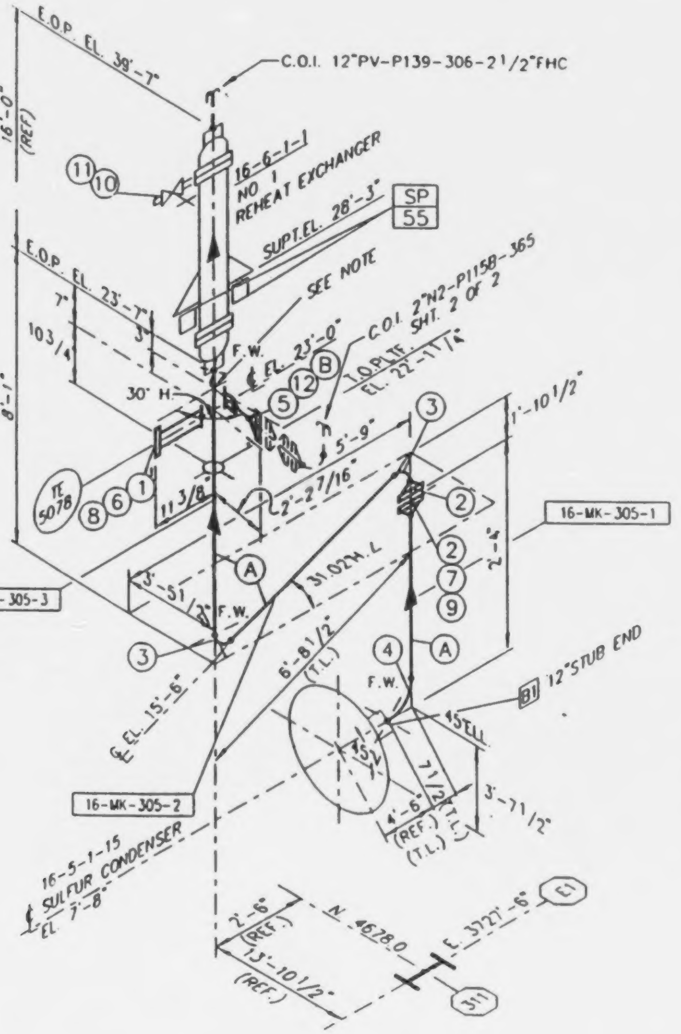
Information Sheet

2. **Purposes of isometric and spool drawings**
    a. For detailing and dimensioning piping systems
    b. For ordering final talley parts
    c. For flagging and detailing special pipe components
    d. For shop fabrication
    e. For installation in the field by construction crews
3. **Information on the drawing side of an isometric/spool drawing**
    a. Fitting symbol
    b. Equipment item numbers and titles
    c. Dimensions center to center, face to face, or center to face
    d. Instrumentation balloons
    e. Connecting line numbers
    f. North arrow
    g. Pipe size and numbering
    h. Centerline elevations
    i. Flow direction

Information Sheet

j. Shop and field welds

k. Erection marks (spool marks)


E.O.P. EL. 39'-7"
16'-0" (REF)
C.O.I. 12"PV-P139-306-2 1/2"FHC
11
10
16-6-1-1
NO 1
REHEAT EXCHANGER
SUPT.EL. 28'-3"
SP
55
E.O.P. EL. 23'-7"
7"
3"
10 3/4
SEE NOTE
C.O.I. 2"N2-P1158-365 SHT. 2 OF 2
F.W.
℄ EL. 23'-0"
T.O.PLTF. EL. 22'-11 1/2"
B
12
5
30° H.
8'-1"
3
1'-10 1/2"
5'-9"
TE 5078
8
6
1
11 3/8"
2'-2 7/16"
2
16-MK-305-1
2
7
9
2'-4"
A
31.02° H.L
16-MK-305-3
3'-5 1/2"
F.W.
3
6'-8 1/2" (T.L.)
4
A
F.W.
B1
12"STUB END
45°ELL
℄ EL. 15'-6"
45°
16-MK-305-2
7 1/2" (T.L.)
4'-6" (REF.) (T.L.)
3'-7 1/2"
16-5-1-15
SULFUR CONDENSER
℄ EL. 7'-8"
2'-6" (REF.)
N. 4628.0
E. 3727'-6"
E1
13'-10 1/2" (REF.)
J11

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Information Sheet

4. **Information on the BOM side of an isometric/spool drawing**

   a. Line number

   b. Stress relieving notation

   c. X-ray notation

   d. Hydrostatic testing pressure

   e. Insulation thickness

   f. Design pressure

   g. Operating pressure

   h. Design temperature

   i. Operating temperature

   j. Pipe lengths, specs, and grades

   k. Flange, fitting, and valve quantities, sizes, ratings, types, and materials

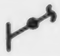
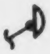
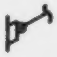
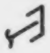
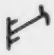
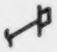
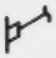
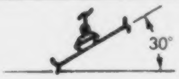
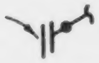
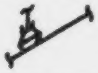
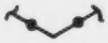
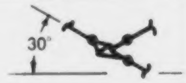
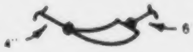
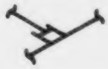
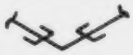
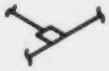
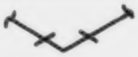
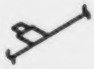
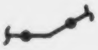
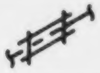
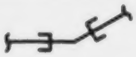
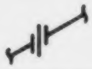
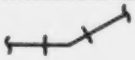
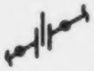
   l. Bolt and gasket quantities, diameters, sizes, lengths, and materials

   m. General notes

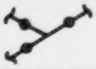
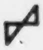
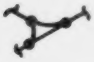
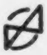
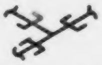
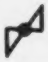
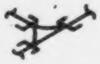
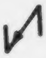
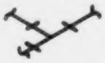
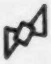
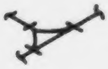
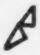
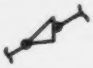
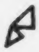
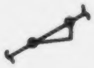
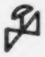
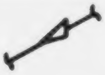
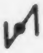
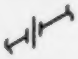
   Note: See TM 5.

Information Sheet

5. Single line isometric symbols

Fitting	Symbol	Fitting	Symbol
FLANGE, WN		CAP, WELDED	
FLANGE, SO		CAP, SW	
FLANGE, SW		CAP, SCRD	
FLANGE, SCRD		WELD-O-LET	
FLANGE, BLD		SOCKET-O-LET	
ELBOW, 90°		ELBOW-O-LET	
ELBOW, 90° RED		CPLG, SW	
ELBOW, 90° SW		CPLG, THREADED	
ELBOW, 90° SCRD		PLUG, SCRD	
ELBOW, 45°		DRESSER CPLG	
ELBOW, 45° SW		ORIFICE, SCRD	
ELBOW, 45° SCRD		ORIFICE, FLGD	

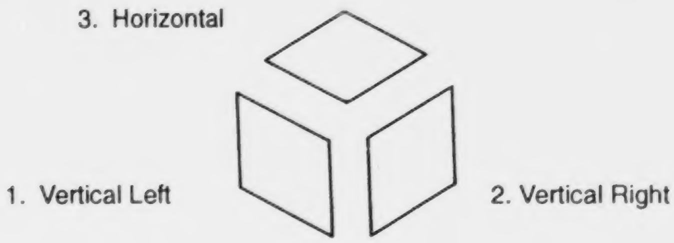
Information Sheet

Fitting	Symbol	Fitting	Symbol
TEE, BUTT WELD		GATE VA	
TEE, RED		BALL VA	
TEE, SW		GLOBE VA	
TEE, SW RED		CHECK VA	
TEE, SCRD		PLUG VA	
TEE, SCRD RED		ANGLE VA	
RED, CONC		RELIEF VA	
RED, ECC		CONTROL VA	
SWAGE		BUTTERFLY VA	
UNION			

Information Sheet

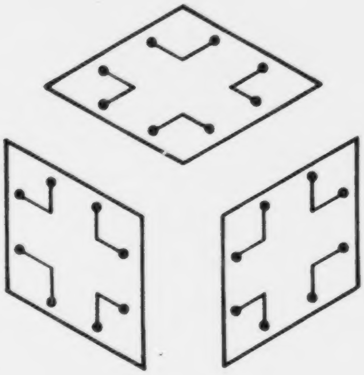
6. Basic rules for isometric fitting representations

a. There are three main planes in isometric dimensioning

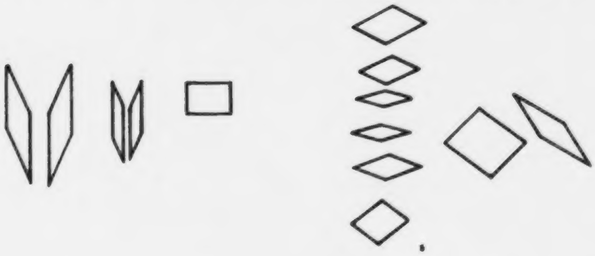

3. Horizontal
1. Vertical Left
2. Vertical Right

b. Each fitting has four main representations in each plane.

Example: Plane and representations for a 90° long radius elbow



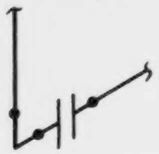
c. There can be an infinite number of supplementary planes.



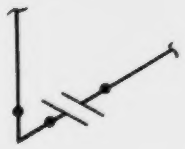
Information Sheet

d. Draw flange symbols parallel with the isometric plane.

Correct (Vertical Right)



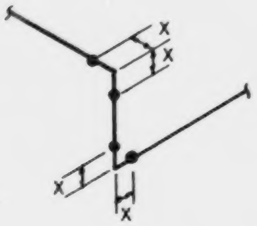
Incorrect



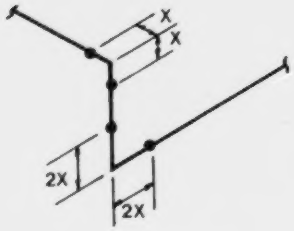
e. Do not draw fittings to scale, but draw them as close to actual representations as possible.

f. If you draw a fitting on a drawing more than once, do not change the size.

Correct



Incorrect

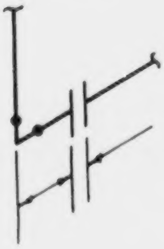


g. If a special fitting has no symbol, draw a new symbol and note it in the legend.

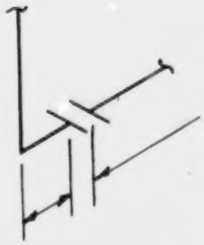
7. **Procedures for dimensioning isometrics**

a. Draw dimension lines in line with flanges so that they are parallel with the isometric plane.

Correct



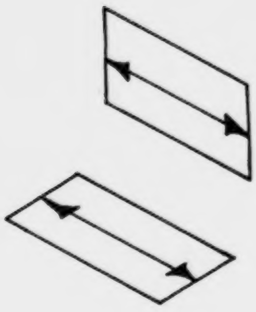
Incorrect



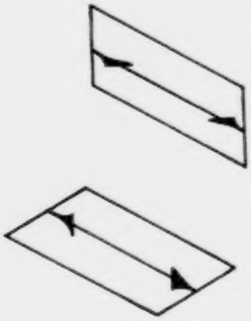
Information Sheet

b. Draw arrowheads in the same plane as dimension and extension lines.

Correct

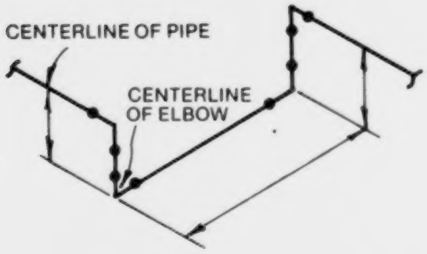


Incorrect

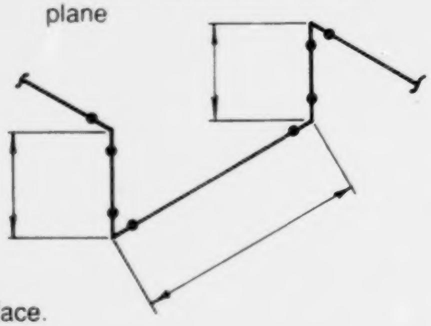


c. Draw dimension lines from centerline to centerline.

Correct

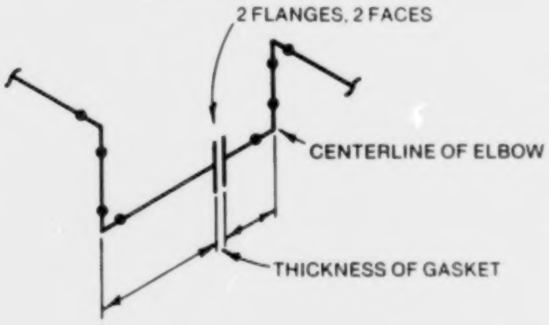

CENTERLINE OF PIPE
CENTERLINE OF ELBOW

Incorrect—Lines not in correct plane

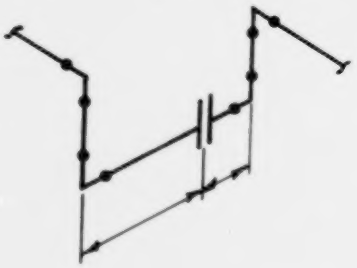


d. Draw dimension lines from centerline to face.

Correct


2 FLANGES, 2 FACES
CENTERLINE OF ELBOW
THICKNESS OF GASKET

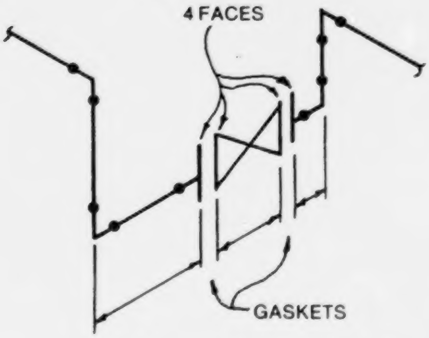
Incorrect—Not to face



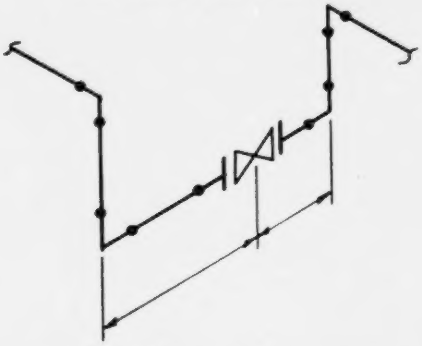
Information Sheet

e. Draw dimension lines from face to face.

Correct

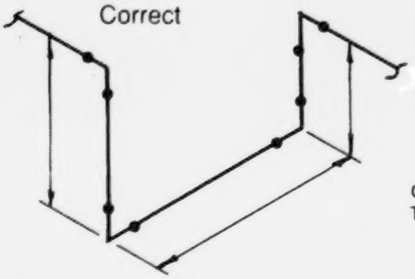

4 FACES
GASKETS

Incorrect—Not to face

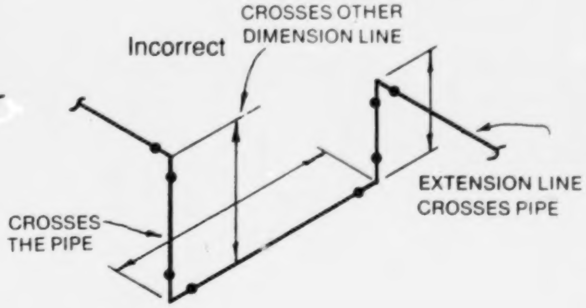


f. Do not permit dimension lines to cross pipe, other dimension lines, or extension lines.

Correct



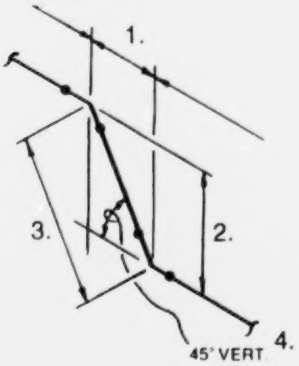
Incorrect


CROSSES OTHER DIMENSION LINE
EXTENSION LINE CROSSES PIPE
CROSSES THE PIPE

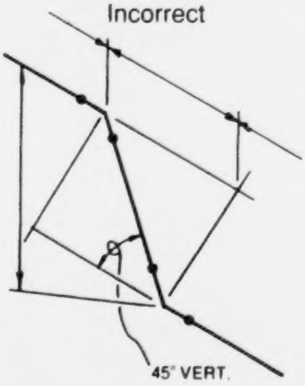
8. Guidelines for dimensioning angle and rolled offsets

a. Dimension angle offsets and show vertical distances in the correct planes.

Correct (vertical left)


1.
3.
2.
4.
45° VERT.

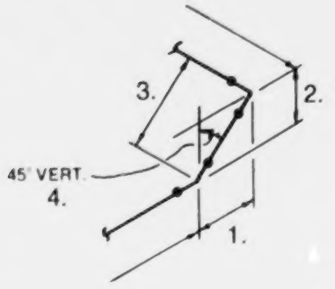
Incorrect



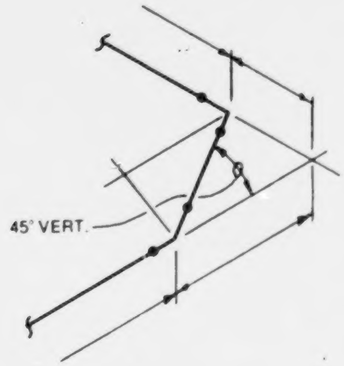
Information Sheet

b. Show horizontal distance and angle offsets in the correct plane.

Correct (vertical right)

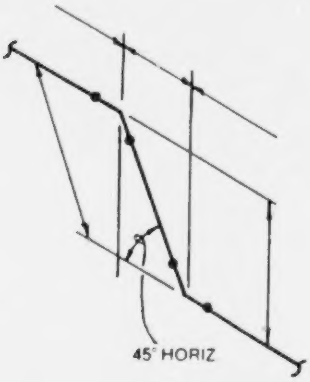

3.
2.
45° VERT.
4.
1.

Incorrect

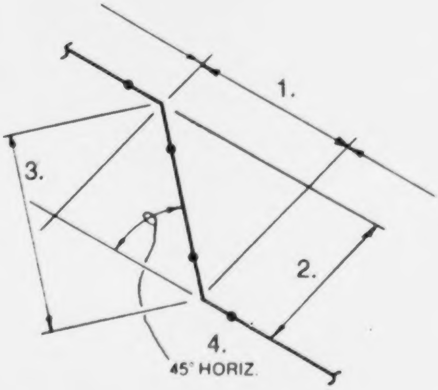


c. Indicate length of pipe and angular measurement for angle offsets.

Correct



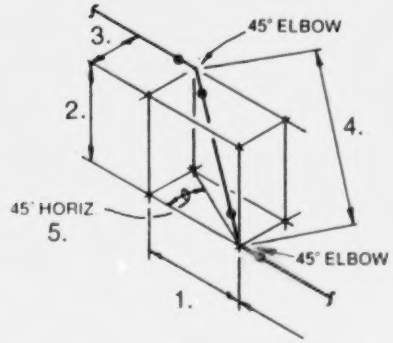
Incorrect


1.
3.
2.
4.
45° HORIZ.

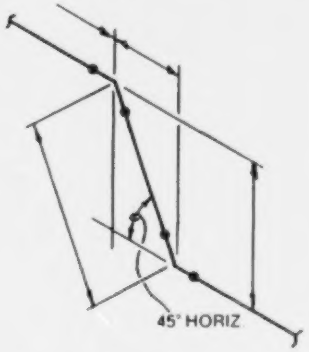
Information Sheet

d. Dimension rolled offsets to show vertical and horizontal distances.

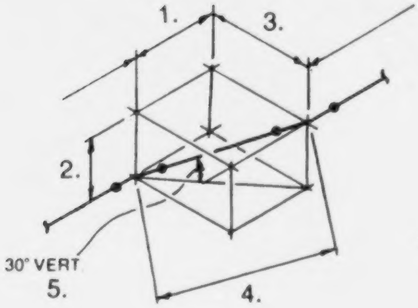
Correct (vertical left)


3.
45° ELBOW
2.
4.
45° HORIZ
5.
45° ELBOW
1.

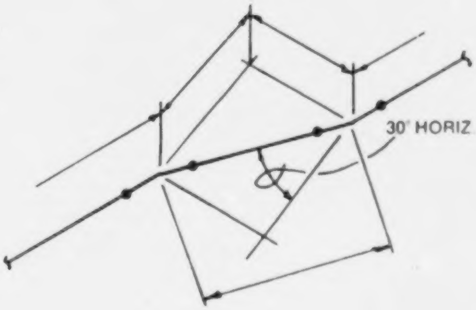
Incorrect



Correct (vertical right)


1.
3.
2.
30° VERT
5.
4.

Incorrect



e. Show rolled offset depth dimensions as well as length of pipe and angular measurement.

Information Sheet

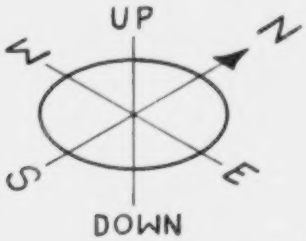
9. **Guidelines for drawing and placing a north arrow.**

   a. For all piping isometrics, construct a north arrow to show the direction a line is traveling in relationship to north.

   b. Draw north arrows with the arrow pointing at an angle to the right; this is called the preferred method.

   Note: The preferred method may vary with company standards.

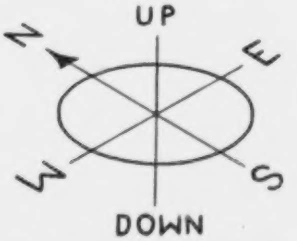
   Preferred Method



   c. Place the north arrow in the upper right hand corner on the drawing side of the isometric.

   d. Use the alternate method with the north arrow pointing at an angle to the left only for irregular applications or as company standards dictate.

   Alternate Method



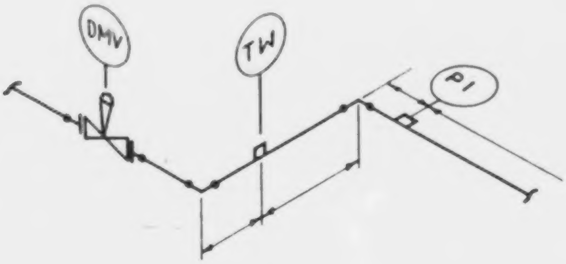
10. **Guidelines for drawing and lettering an instrumentation balloon**

   a. Call out instrumentation by drawing and lettering an instrumentation balloon.

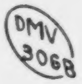
   b. Use a 7/16″ diameter isometric ellipse template to make the balloon.

Information Sheet

c. Keep lettering in the correct plane.



d. Open the balloon as required if lettering demands extra room.



11. Guidelines for drawing connecting lines and numbers

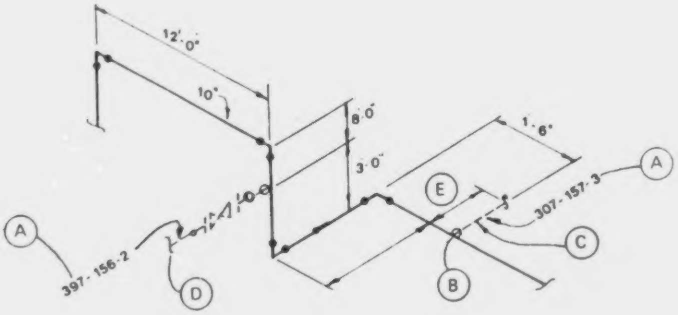
a. Call out connecting lines in full to clarify the beginning and ending of continuing spools.

b. To indicate a field weld, draw an open dot where the line connects to another line.

c. Draw connecting lines as hidden lines.

d. Break connecting lines only on pipe, never on fittings or valves.

e. Do not dimension connecting lines.



Information Sheet

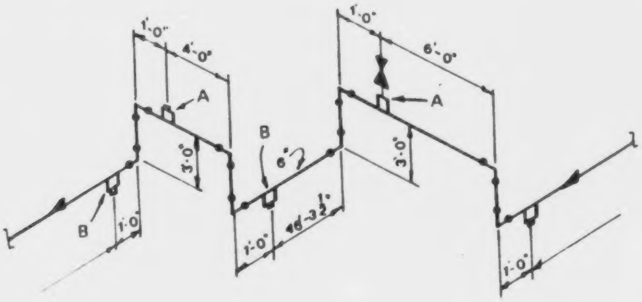
12. Guidelines for drawing and placing vents and drains

a. Because vents are used to let air out when filling up a line, place vent couplings only at high points of a line.

Note: Both vent and drain couplings may have either a plug or a valve screwed into them according to customer specifications.

b. Because drains are used to let water out of a line after testing, place drain couplings only at low points of a line.

Note: Vents and drains may also be used as needed after the line is in service; they can provide points for taking samples from a line or serve as points for pressure testing.

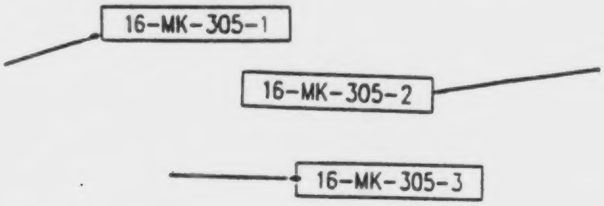


13. Guidelines for drawing and placing shop and field erection marks

a. Use mark numbers to reference different spool drawings.

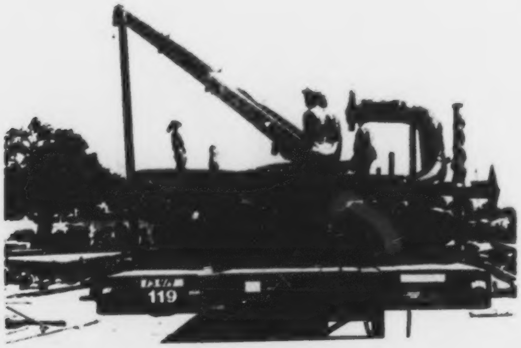
b. Construct mark numbers with two numbers—the first number is the line number, and the second number is the piece number.

c. Place mark numbers on the isometric in rectangular boxes with leader lines.



Information Sheet

Example: Mark numbers help identify spools so that their sizes can be referenced for any activity. If a spool is going to be delivered to the job site on a truck bed that is 8′ wide, 8′ high, and 40′ long, then the spool can be no bigger than 8′ × 8′ × 40′.

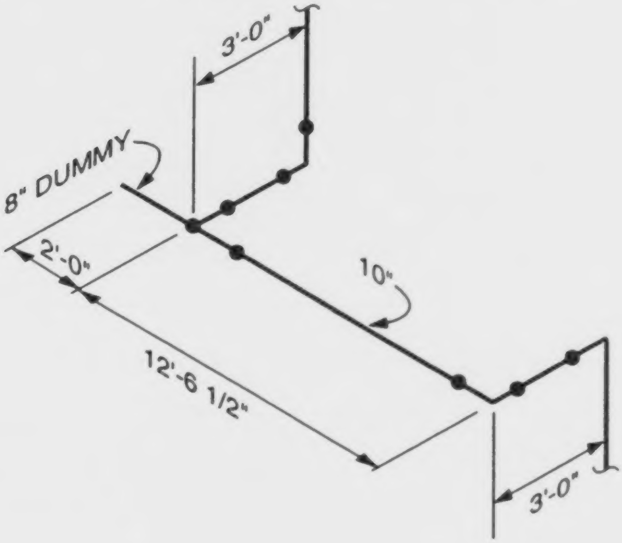


14. Guidelines for noting and drawing dummy supports

a. Make dummy supports from pieces of pipe welded to other pieces of pipe, and use them in stress areas where piping needs extra support.

b. Make dummy supports from pipe one size smaller than the pipe they are supporting.

c. Dimension dummy supports from the centerline of the elbow to the end of the dummy.



Isometric
Unit 6

Assignment Sheet 1—Fill Out a BOM and Calculate Lengths of Pipe, Part A

Student Name ______________________ Overall Rating __________

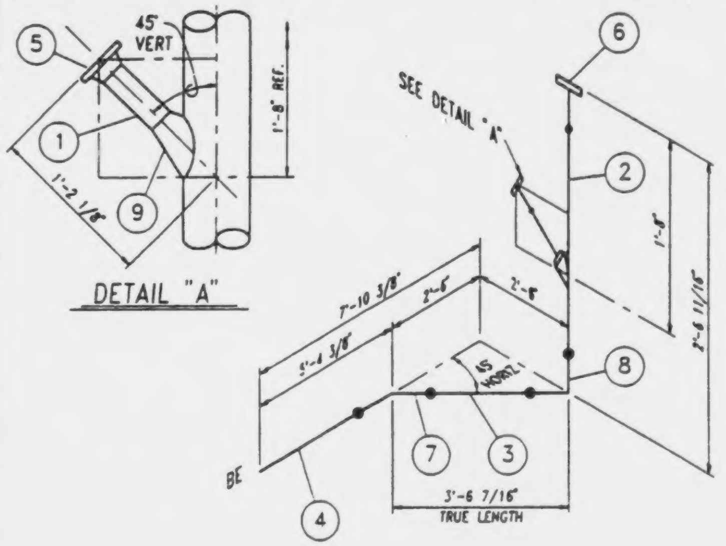
Evaluation criteria	**Rating**
Correct components specified	______
Correct calculations of pipe lengths	______

Directions: Examine the spool drawings 1, 2, and 3 that accompany this assignment sheet and specify the required components on the BOM chart beside each drawing. Be sure to calculate and note the necessary lengths of pipe with each entry on the BOM.

Assignment Sheet 1

Spool Drawing 1

USE WELD PROCEDURES: 1-M-1(ER70S-6) OR 1-TM-1(ER70S-6) OR 1-TS-1(ER70S-6/E7018)


5
45° VERT
1'-8" REF.
1
1'-2 1/8"
9
DETAIL "A"
6
SEE DETAIL "A"
2
1'-8"
2'-6 11/16"
7'-10 3/8"
2'-6"
2'-8"
5'-4 3/8"
45° HORIZ.
8
7
3
BE
4
3'-6 7/16"
TRUE LENGTH

ITEM	QTY.	DESCRIPTION	
9	1	LATEROLET 1 1/2" SCH 80 ON 8" BW	A105
8	1	ELBOW 8" SCH LR BW	A234-WPB
7	1	ELBOW 8" SCH LR BW	A234-WPB
6	1	FLANGE 8" 300# RF WN SCH 20	A105
5	1	FLANGE 300# RF WN SCH 80	A105
4	1	PIPE 8" SCH (BBE)	
3	1	PIPE 8" SCH (BBE)	
2	1	PIPE 8" SCH (BBE)	
1	1	PIPE 1 1/2" SCH 80 X 6" LG.(TRIM) (BBE)	A106-Gr. B

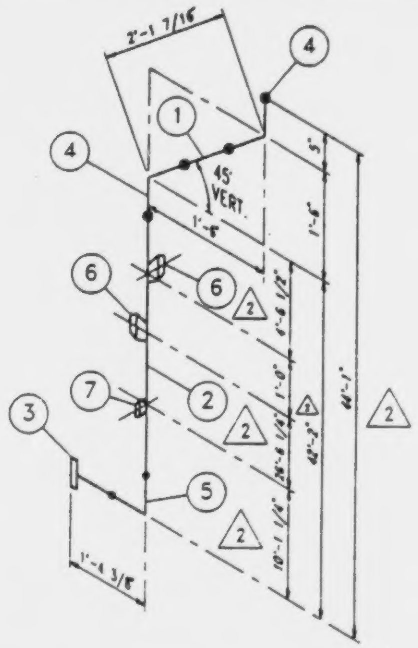
REV 1			REV 2		
REV 3			REV 4		
NONE	10% BW	NONE	NONE	YES	ANSI B31.3
HYDROTEST	RADIOGRAPHY	HEAT TREAT	MAG. CHECK	PT	CODE
DWG. REF. B-1170 SHT.2	CUST. SPEC.	DWN. CBG	CHK. WW	DATE 6-19-83	
DESCRIPTION SPOOL			MK. NO. 1170-J310-2-C		
CUSTOMER			QTY. ONE	S.O. NO. 1080-A1	DWG. NO. 33 REV. 0

piping companies inc.
Box 190, Sand Springs, OK 74063
Telephone (918) 245-6606

Assignment Sheet 1

Spool Drawing 2

USE WELD PROCEDURES: 1-M-1(ER70S-6) OR 1-TM-1(ER70S-6) OR 1-TS-1(ER70S-6/E7018)



ITEM	QTY.	DESCRIPTION			
7	1	SOCKOLET	1" 3000# ON 8" SW		A105
6	2	WELDOLET	6" SCH 20 ON 8" BW		A105
5	1	ELBOW	8" SCH 20 BW		A234-WPB
4	2	ELBOW	8" SCH 20 BW		A234-WPB
3	1	FLANGE	300# RF WN SCH 20		A105
2	1	PIPE	8" SCH 20 X (BBE)	1	A53-Gr. B
1	1	PIPE	8" SCH 20 X 1'-3 7/16" LG. (BBE)		A53-Gr. B

REV 1 REDRAWN PER CUST. REV. 7-1-93			REV 2 REVISED PER FIELD VERIF. 7-8-93BG		
REV 3			REV 4		
NONE	10% BW	NONE	NONE	YES	ANSI B31.3
HYDROTEST	RADIOGRAPHY	HEAT TREAT	MAG. CHECK	PT	CODE
DWG. REF. B-1213 SHT.1	CUST. SPEC.		DWN. CBG	CHK. WW	DATE 6-16-93
DESCRIPTION SPOOL					1213-J31C-1-C
CUSTOMER			QTY ONE	S.O. NO. 1080-A1	DWG. NO. 8 REV. 2

piping companies inc.
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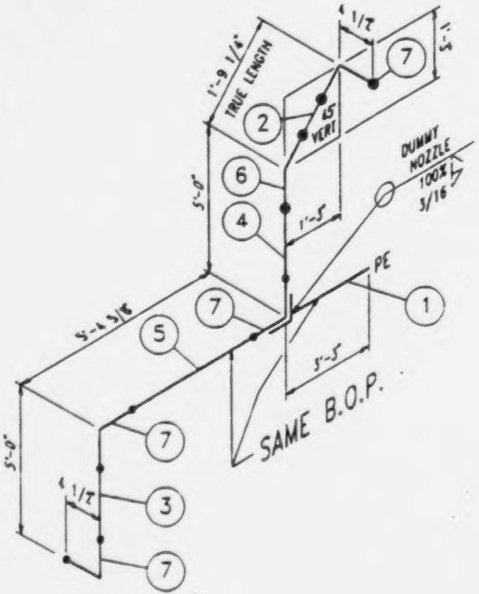
Assignment Sheet 1

Spool Drawing 3

USE WELD PROCEDURES: 1-M-1(ER70S-6) OR 1-TM-1(ER70S-6) OR 1-TS-1(ER70S-6/E7018)


4 1/2
1'-5
7
1'-9 1/4"
TRUE LENGTH
2
45°
VERT
DUMMY
NOZZLE
100%
3/16
6
5'-0"
4
1'-5
PE
1
7
5'-6 5/8
5
3'-5
SAME B.O.P.
7
5'-0"
4 1/2
3
7

ITEM	QTY.	DESCRIPTION				
7	4	ELBOW	SCH 40	BW		A234-WPB
6	1	ELBOW	SCH 40	BW		A234-WPB
5	1	PIPE	3" SCH		(BBE)	A53-Gr. B
4	1	PIPE	3" SCH		(BBE)	A53-Gr. B
3	1	PIPE	3" SCH		(BBE)	A53-Gr. B
2	1	PIPE	3" SCH		(BBE)	A53-Gr. B
1	1	PIPE	S/40 X 3'-7" LG.	(TRIM)	(PE-NOZ)	A106-Gr. B

REV 1			REV 2		
REV 3			REV 4		
NONE	5% BW	NONE	NONE	YES	ANSI B31.3
HYDROTEST	RADIOGRAPHY	HEAT TREAT	MAG. CHECK	PT	CODE
DWG. REF. B-1189 SHT.2	CUST. SPEC.	DWN. CBG	CHK. WW	DATE 6-18-93	
DESCRIPTION SPOOL			MK. NO. 1189-J148-2-A		
CUSTOMER			QTY. ONE	S.O. NO. 1080-A1	DWG. NO. 26 REV. 0

piping companies inc.
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Isometric
Unit 6

Assignment Sheet 2—Fill Out a BOM and Calculate Lengths of Pipe, Part B

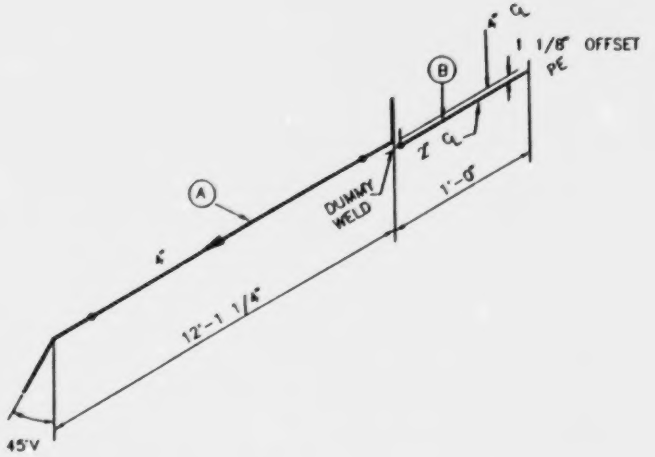
Student Name ______________________________ Overall Rating __________

Evaluation criteria	**Rating**
Correct components specified	______
Correct calculations of pipe lengths	______

Directions: Examine the spool drawings 1, 2, and 3 that accompany this assignment sheet and specify the required components on the BOM chart beside each drawing. Be sure to calculate and note the necessary lengths of pipe with each entry on the BOM.

Assignment Sheet 2

Spool Drawing 1


4" ℄
1 1/8" OFFSET
PE
B
2" ℄
1'-0"
A
DUMMY WELD
4"
12'-1 1/4"
45°V

QUAN. DESCRIPTION

(2) ELL

(1) 2" END PROT

(2) 4" END PROT

STD A106-B SMLS

A (1) 2BE

SUPT MAT'L

X-HVY A-106-B SMLS

B (1) 2" 1'-6" 2PE

C.I.

L.I.C.

COLOR CODE BLUE

NOTES:

WT. EACH

PAINT TYPE 1

HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA

10%

B31.3

JOB NO. WORD IND

ONE

SHT-B-A

STD SHT, "B"

P.O. NO. ENGR. STD

WI

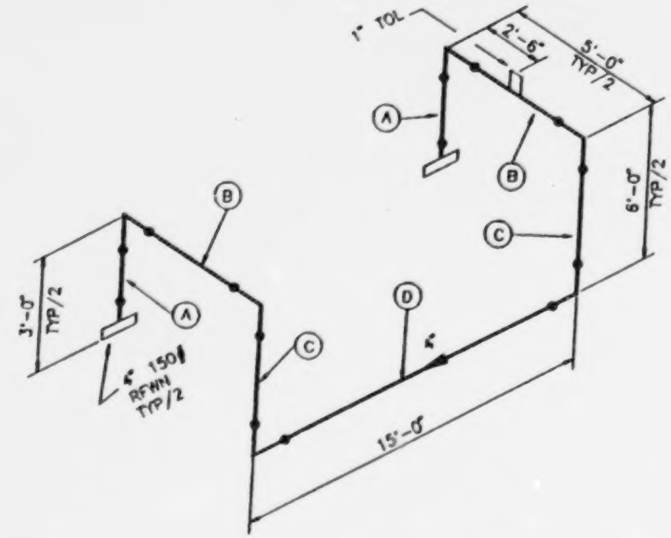
1

B

B

Assignment Sheet 2

Spool Drawing 2


1" TOL
2'-6"
5'-0" TYP/2
A
B
6'-0" TYP/2
C
B
3'-0" TYP/2
A
4" 150# RFWN TYP/2
C
D
4"
15'-0"

QUAN.	DESCRIPTION	
( )	4" STD L.R.	ELL
(2)	4"	(STD-B)
(1)	1" ON 4" 3000# T-O-L	
(1)	1" END PROT	
(2)	4" 150# FLG PROT	
	STD A106-B SMLS	
A (2)	4"	2BE
B (2)	4"	2BE
C (2)	4"	2BE
D (1)	4"	2BE
	TOTAL=	

C.I.__________
L.I.C.__________
NOTES:

COLOR CODE BLUE

WT. EACH

PAINT NONE

HEAT TR.

10%

ONE

SHT-N

SHT-N R/0

B31.3

WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA

JOB NO. WORD IND

P.O. NO. ENGR STD

WI

PRIORITY

1

0

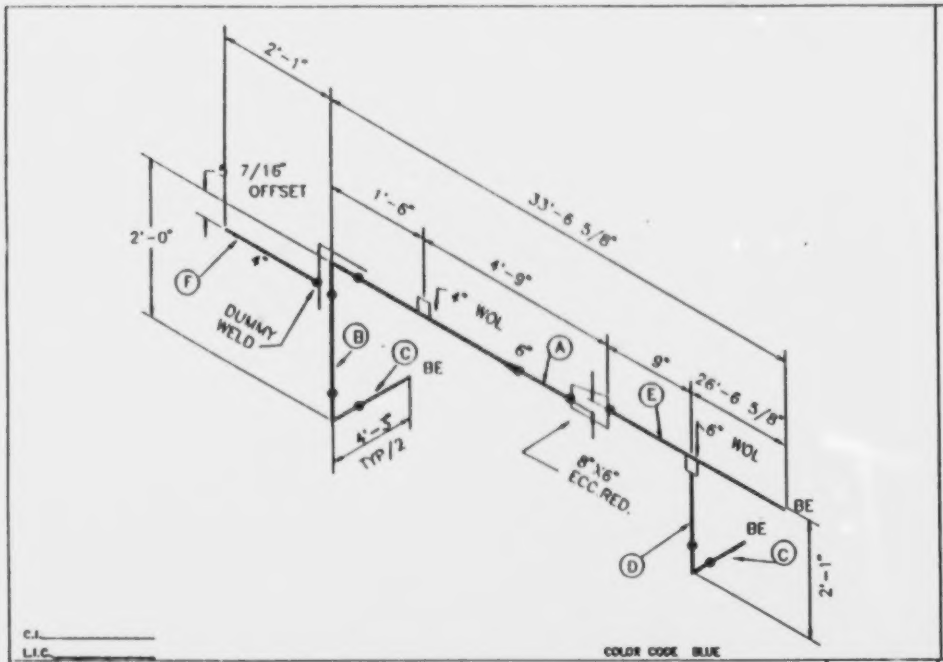
N

$

N

Assignment Sheet 2

Spool Drawing 3


2'-1"
33'-6 5/8"
5 7/16" OFFSET
1'-6"
2'-0"
4"
F
DUMMY WELD
4" WOL
4'-9"
B
C
BE
6"
A
4'-5
TYP/2
9"
E
26'-6 5/8"
6" WOL
8"X6" ECC.RED.
BE
BE
D
C
2'-1"
C.I.
L.I.C.
COLOR CODE BLUE

QUAN.	DESCRIPTION
(3)	6" STD
(1)	ECC.RED.
(1)	4" ON 6" STD W-O-L
(1)	6" ON 8" STD W-O-L
(2)	4" END PROT
(2)	6" END PROT
(1)	8" END PROT
	STD A106-B SMLS
A (1)	6" 2BE
B (1)	6" 2BE
C (2)	6" 2BE
D (1)	6" 2BE
	TOTAL=
E (1)	8"
	SUPT MAT'L STD A106-B SMLS
F (1)	4" 2'-2 3/4" 2PE

NOTES:

WT. EACH

PAINT NONE

HEAT TR.

WORD INDUSTRIES
PIPE FABRICATING
TULSA, OKLAHOMA

10%				B31.3	JOB NO. WORD IND	WI				$
ONE	P.O. NO. SHT-U	SHT-U R/O			P.O. NO. ENGR STD	PRIORITY	1	1	U	U

Isometric
Unit 6

Assignment Sheet 3—Draw Spool Drawings From Isometric A

Student Name ______________________ Overall Rating __________

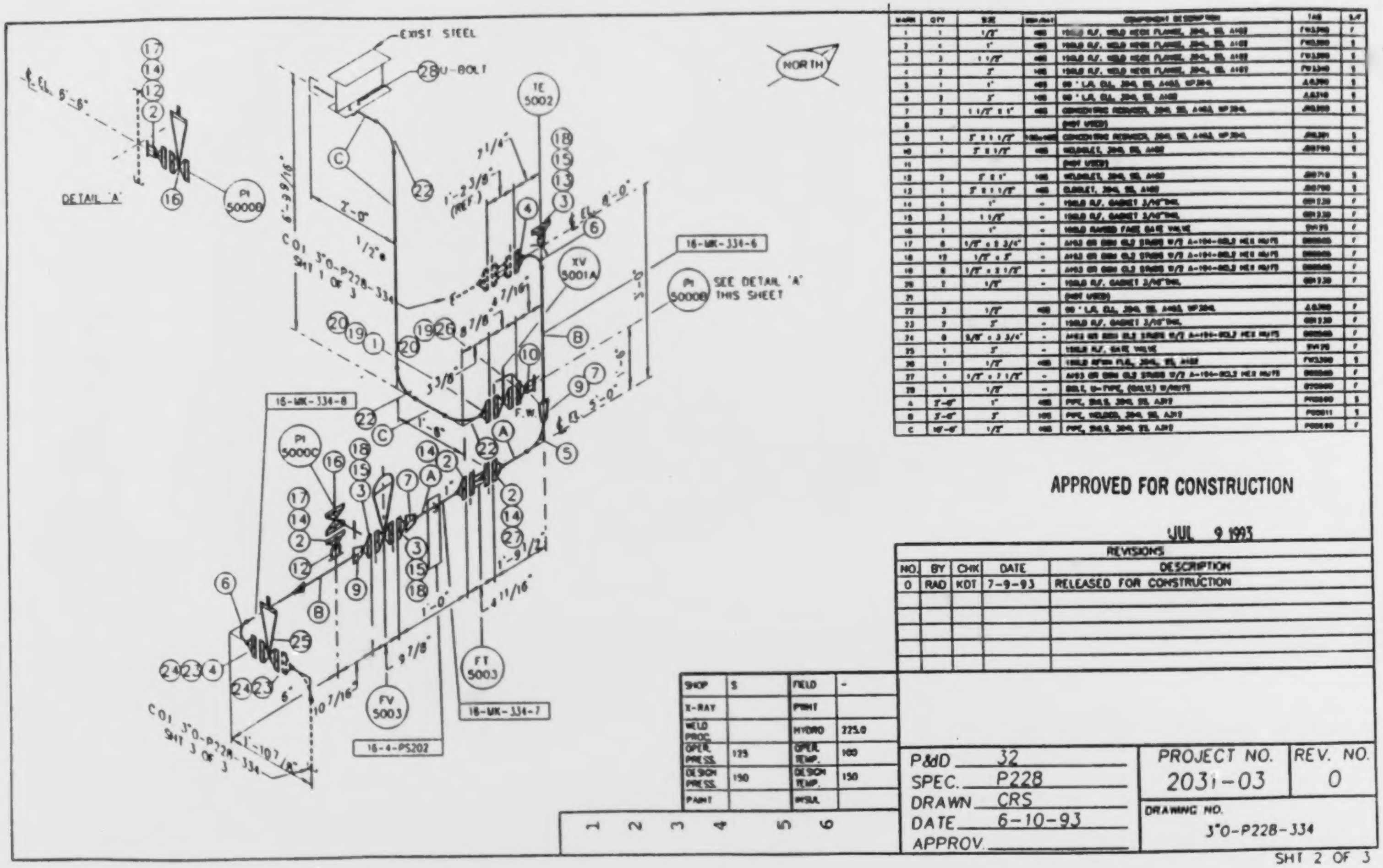
Evaluation criteria	**Rating**
Isometric broken into correct spools	______
Components correctly specified	______
Correct calculation of pipe lengths	______
Title block correctly filled out	______
Total weight correctly calculated	______

Directions: Examine Isometric A that accompanies this assignment sheet and break it into the correct number of spools. Then, complete the following steps.

1. Completely detail the spools for fabrication.
2. Specify the components for the spool on a BOM.
3. Calculate and note on the BOM the necessary lengths of pipe.
4. Fill out the title block.
5. Calculate the total weight of the assembly.

Assignment Sheet 3

Isometric A


EXIST. STEEL
28 U-BOLT
NORTH
℄ EL. 5'-6"
DETAIL 'A'
PI 5000D
TE 5002
7 1/4"
1'-2 3/8" (REF.)
℄ EL. 8'-0"
16-WK-334-6
XV 5001A
PI 5000B SEE DETAIL 'A' THIS SHEET
6'-3 9/16"
2'-0"
1/2"
CO1 3"0-P228-334 SHT 1 OF 3
4 7/16"
8 7/8"
3 3/8"
F.W.
℄ EL. 5'-0"
16-WK-334-8
1'-8"
PI 5000C
1'-0"
1'-9 1/2"
4 11/16"
9 7/8"
10 7/16"
6"
1'-10 7/8"
CO1 3"0-P228-334 SHT 3 OF 3
FV 5003
FT 5003
16-4-PS202
16-WK-334-7
1 2 3 4 5 6

MARK	QTY	SIZE	SCH/RAT	COMPONENT DESCRIPTION	TAG	S/F
1	1	1/2"	40S	150LB R/F, WELD NECK FLANGE, 304L, SS, A182	[illegible]	F
2	4	1"	40S	150LB R/F, WELD NECK FLANGE, 304L, SS, A182	[illegible]	S
3	3	1 1/2"	40S	150LB R/F, WELD NECK FLANGE, 304L, SS, A182	[illegible]	S
4	2	3"	10S	150LB R/F, WELD NECK FLANGE, 304L, SS, A182	[illegible]	S
5	1	1"	40S	90° L.R. ELL, 304L, SS, A403, WP304L	[illegible]	S
6	2	3"	10S	90° L.R. ELL, 304L, SS, A403	[illegible]	S
7	2	1 1/2" x 1"	40S	CONCENTRIC REDUCER, 304L, SS, A403, WP304L	[illegible]	S
8				(NOT USED)		
9	1	3" x 1 1/2"	10S x 40S	CONCENTRIC REDUCER, 304L, SS, A403, WP304L	[illegible]	S
10	1	3" x 1/2"	40S	WELDOLET, 304L, SS, A182	[illegible]	S
11				(NOT USED)		
12	2	3" x 1"	10S	WELDOLET, 304L, SS, A182	[illegible]	S
13	1	3" x 1 1/2"	40S	ELBOLET, 304L, SS, A182	[illegible]	S
14	4	1"	-	150LB R/F, GASKET 1/16" THK.	[illegible]	F
15	3	1 1/2"	-	150LB R/F, GASKET 1/16" THK.	[illegible]	F
16	1	1"	-	150LB RAISED FACE GATE VALVE	[illegible]	F
17	8	1/2" x 2 3/4"	-	A193 GR B8M CL2 STUDS W/2 A-194-8M HEX NUTS	[illegible]	F
18	12	1/2" x 3"	-	A193 GR B8M CL2 STUDS W/2 A-194-8M HEX NUTS	[illegible]	F
19	8	1/2" x 2 1/2"	-	A193 GR B8M CL2 STUDS W/2 A-194-8M HEX NUTS	[illegible]	F
20	2	1/2"	-	150LB R/F, GASKET 1/16" THK.	[illegible]	F
21				(NOT USED)		
22	3	1/2"	40S	90° L.R. ELL, 304L, SS, A403, WP304L	[illegible]	F
23	2	3"	-	150LB R/F, GASKET 1/16" THK.	[illegible]	F
24	8	5/8" x 3 3/4"	-	A193 GR B8M CL2 STUDS W/2 A-194-8M HEX NUTS	[illegible]	F
25	1	3"	-	150LB R/F, GATE VALVE	[illegible]	F
26	1	1/2"	40S	150LB [illegible] FLG, 304L, SS, A182	[illegible]	S
27	4	1/2" x 2 1/2"	-	A193 GR B8M CL2 STUDS W/2 A-194-8M HEX NUTS	[illegible]	F
28	1	1/2"	-	BOLT, U-TYPE, (GALV.) W/NUTS	[illegible]	F
A	7'-6"	1"	40S	PIPE, SMLS, 304L, SS, A312	[illegible]	S
B	3'-6"	3"	10S	PIPE, WELDED, 304L, SS, A312	[illegible]	S
C	16'-6"	1/2"	40S	PIPE, SMLS, 304L, SS, A312	[illegible]	F

APPROVED FOR CONSTRUCTION

JUL 9 1993

REVISIONS

NO.	BY	CHK	DATE	DESCRIPTION
0	RAD	KDT	7-9-93	RELEASED FOR CONSTRUCTION

SHOP	S	FIELD	-
X-RAY		PRINT	
WELD PROC.		HYDRO	225.0
OPER. PRESS.	125	OPER. TEMP.	100
DESIGN PRESS.	150	DESIGN TEMP.	150
PAINT		INSUL.	

P&ID 32
SPEC. P228
DRAWN CRS
DATE 6-10-93
APPROV.

PROJECT NO. 2031-03

REV. NO. 0

DRAWING NO. 3"0-P228-334

SHT 2 OF 3

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Isometric
Unit 6

Assignment Sheet 4—Draw Spool Drawings From Isometric B

Student Name ________________________ Overall Rating __________

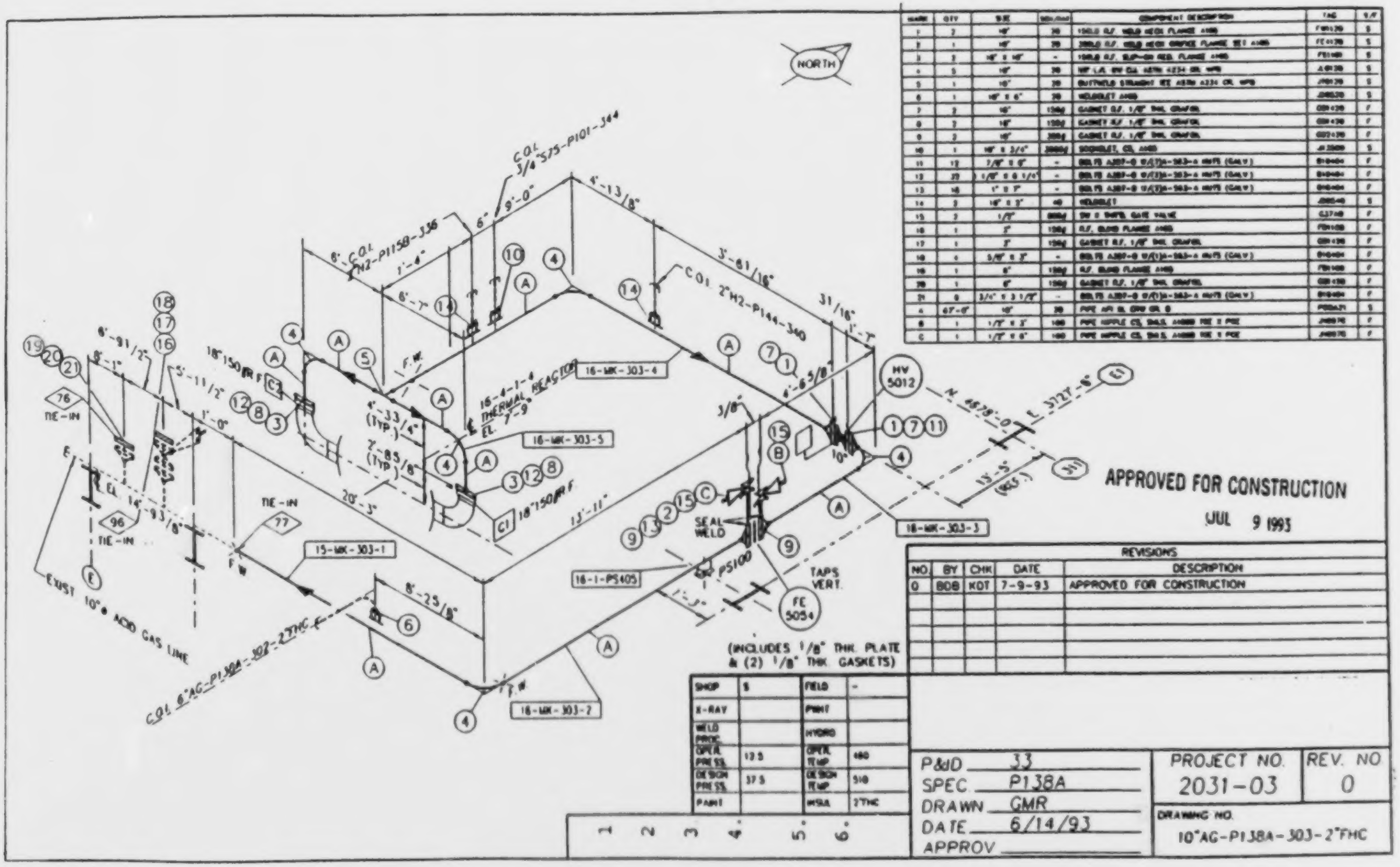
Evaluation criteria	Rating
Isometric broken into correct spools	______
Components correctly specified	______
Correct calculation of pipe lengths	______
Title block correctly filled out	______
Total weight correctly calculated	______

Directions: Examine Isometric B that accompanies this assignment sheet and break it into the correct number of spools. Then, complete the following steps.

1. Completely detail the spools for fabrication.
2. Specify the components for the spool on a BOM.
3. Calculate and note on the BOM the necessary lengths of pipe.
4. Fill out the title block.
5. Calculate the total weight of the assembly.

Assignment Sheet 4

Isometric B


NORTH
C.O.L. 3/4"S75-P101-344
8" C.O.L. 2"H2-P115B-336
6"
9'-0"
4'-1 3/8"
1'-6"
6'-7"
3'-6 1/16"
C.O.L. 2"H2-P144-340
3 1/16"
1'-7"
6'-6 5/8"
HV 5012
N. 4578'-0"
E. 3727'-6"
13'-5"
(REF.)
10"
18"150# R.F.
C2
C1
18"150# R.F.
16-4-1-4 THERMAL REACTOR EL. 7'-9"
16-MK-303-4
16-MK-303-5
16-MK-303-3
16-MK-303-2
15-MK-303-1
16-1-PS405
4'-3 3/4" (TYP.)
2'-8 5/8" (TYP.)
20'-3"
13'-11"
F.W.
6'-9 1/2"
8'-1"
5'-11 1/2"
1'-0"
76 TIE-IN
96 TIE-IN
77 TIE-IN
EL. 14'-9 3/8"
E
EXIST. 10"⌀ ACID GAS LINE
C.O.L. 6"AG-P138A-302-2"FHC
8'-2 5/8"
3/8"
SEAL WELD
PS100
TAPS VERT.
FE 5054
1'-3"
(INCLUDES 1/8" THK. PLATE & (2) 1/8" THK. GASKETS)

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JUL 9 1993

SHOP	S	FIELD	-
X-RAY		PAINT	
WELD PROC.		HYDRO	
OPER. PRESS.	12.5	OPER. TEMP.	480
DESIGN PRESS.	37.5	DESIGN TEMP.	510
PAINT		INSUL.	2"THC

1 2 3 4 5 6

REVISIONS				
NO.	BY	CHK	DATE	DESCRIPTION
0	BOB	KOT	7-9-93	APPROVED FOR CONSTRUCTION

P&ID 33
SPEC P138A
DRAWN GMR
DATE 6/14/93
APPROV

PROJECT NO. 2031-03

REV. NO 0

DRAWING NO. 10"AG-P138A-303-2"FHC

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506

507

Isometric
Unit 6

Assignment Sheet 5—Draw Spool Drawings From Isometric C

Student Name ______________________ Overall Rating __________

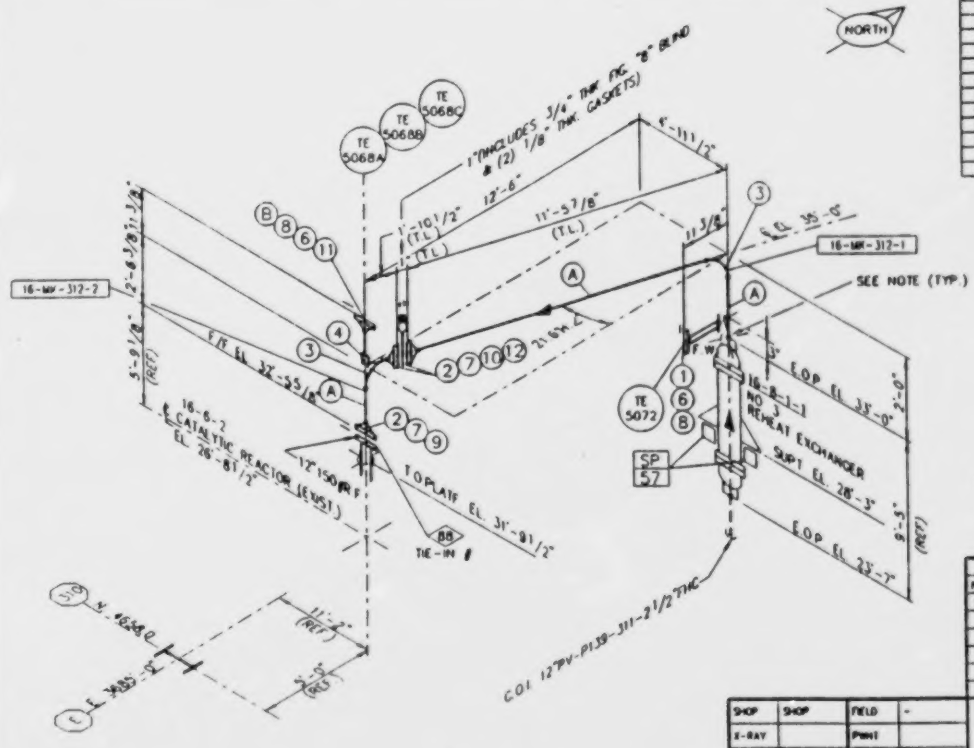
Evaluation criteria	Rating
Isometric broken into correct spools	______
Components correctly specified	______
Correct calculation of pipe lengths	______
Title block correctly filled out	______
Total weight correctly calculated	______

Directions: Examine Isometric C that accompanies this assignment sheet and break it into the correct number of spools. Then, complete the following steps.

1. Completely detail the spools for fabrication.
2. Specify the components for the spool on a BOM.
3. Calculate and note on the BOM the necessary lengths of pipe.
4. Fill out the title block.
5. Calculate the total weight of the assembly.

Assignment Sheet 5

Isometric C


NORTH
TE 5068A
TE 5068B
TE 5068C
1" (INCLUDES 3/4" THK FIG "8" BLIND & (2) 1/8" THK. GASKETS)
12'-6"
6'-11 1/2"
1'-10 1/2" (T.L.)
1' (T.L.)
11'-5 7/8" (T.L.)
11 3/8"
℄ EL 35'-0"
16-MR-312-1
16-MV-312-2
SEE NOTE (TYP.)
B 8 6 11
4
3
A
2 7 10 12
2 7 9
21'-6¾"
12'-6 3/8"
5'-9 1/8" (REF)
F/F EL 32'-5 5/8"
16-B-2 ℄ CATALYTIC REACTOR (EXIST.) EL 26'-8 1/2"
12" 150# RF
TOP PLATF EL 31'-9 1/2"
88 TIE-IN #
F.W.
3"
EOP EL 33'-0"
2'-0"
TE 5072
1 6 B
16-B-1-1 NO. 3 REHEAT EXCHANGER
SUPT EL 28'-3"
SP 57
EOP EL 23'-7"
9'-5" (REF)
CO1 12"PV-P139-311-2 1/2"FHC
N 4688-0
℄ E 3485'-0"
11'-2" (REF)
5'-5" (REF)

MARK	QTY	SIZE	SCH/RAT	COMPONENT DESCRIPTION	TAG	S/F
1	1	1 1/2"	40	1500# R.F. L.G. WN FLANGE A105	[illegible]	S
2	3	12"	STD	150# R.F. WELD NECK FLANGE A105	[illegible]	S
3	2	12"	STD	90° L.R. BW ELL ASTM A234 GR WPB	[illegible]	S
4	1	12" x 1 1/2"	3000#	S.W. ELBOLET A105	[illegible]	S
6	2	1 1/2"	150#	GASKET R.F. 1/16" THK GRAFOIL	[illegible]	F
7	3	12"	150#	GASKET R.F. 1/8" THK GRAFOIL	[illegible]	F
8	8	1/2" x 3"	-	STUD BOLTS A-193 GR B7W (2) A194-2HM NUTS	[illegible]	F
9	12	7/8" x 5"	-	STUD BOLTS A-193 GR B7W (2) A194-2HM NUTS	[illegible]	F
10	1	12"	150#	3/4" THK FIGURE 8 BLIND	[illegible]	F
11	1	1 1/2	40	1500# R.F. WELD NECK FLANGE A105	[illegible]	S
12	12	7/8" x 6"	-	STUD BOLTS A-193 GR B7W (2) A194-2HM NUTS	[illegible]	F
A	12'-6"	12"	STD	PIPE API-5L ERW GR B	[illegible]	S
B	1'-6"	1 1/2"	40	PIPE CS SMLS A106B	[illegible]	S

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JUL 9 1993

NOTE.
SHOP TO PROVIDE 3:1 TAPER BORE TO MATCH
SCH. 20 NOZZLE ON EQUIPMENT

REVISIONS				
NO	BY	CHK	DATE	DESCRIPTION
0	JDS	SPH	7-9-93	APPROVED FOR CONSTRUCTION

SHOP	SHOP	FIELD	-
X-RAY		PAINT	
WELD PROC		HYDRO	
OPER PRESS	8.3	OPER TEMP	372
DESIGN PRESS	31.3	DESIGN TEMP	422
PAINT		INSUL	2 1/2"FHC

1. 2. 3. 4. 5. 6.

P&ID 35
SPEC P139
DRAWN JDS
DATE 6/9/93
APPROV

PROJECT NO.	REV. NC
2031-03	0

DRAWING NO.
12"PV-P139-312-2 1/2"FHC

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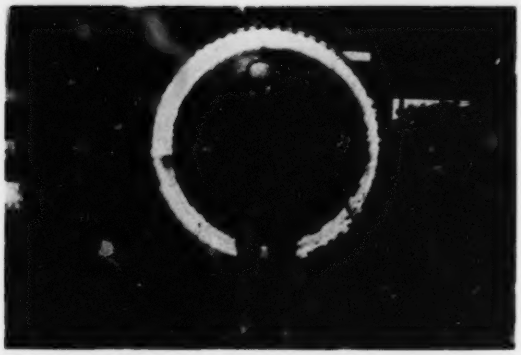


Equipment Fabrication Drawings
Unit 7

Objective Sheet

Unit Objective

After completing this unit, the student should be able to locate nozzle mark numbers and calculate nozzle elevation dimensions and nozzle orientation in degrees. The student should also be able to locate information on a drawing, prepare a schedule of openings, find correct nozzle sizes, and draw a steam drum layout. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to equipment fabrication drawings with their correct definitions.
2. Match equipment types with their applications.
3. Complete statements about information included on an equipment fabrication drawing.
4. Select true statements about information found on a schedule of openings chart.
5. Complete statements about how to transfer information from a mechanical flow diagram to an equipment drawing.
6. Select true statements about characteristics of datum dimensioning of elevation views.
7. Select true statements about characteristics of dimensioning on orientation views.
8. Select true statements about noting nozzle and coupling elevation, orientation, and projection.
9. Match types of pumps with their characteristics.

Objective Sheet

10. Solve problems about selecting and sizing pumps.

11. Select true statements about tubular heat exchangers.

12. Locate nozzle mark numbers on a mechanical flow diagram. (Assignment Sheet 1)

13. Calculate nozzle elevation dimensions from given mark numbers on a manufacturer's drawing. (Assignment Sheet 2)

14. Calculate nozzle orientation in degrees from given mark numbers on a manufacturer's drawing. (Assignment Sheet 3)

15. Locate information on a manufacturer's drawing. (Assignment Sheet 4)

16. Complete a schedule of openings chart from a mechanical flow diagram. (Assignment Sheet 5)

17. Use a pump specification sheet to find nozzle sizes on a flow diagram. (Assignment Sheet 6)

Equipment Fabrication Drawings
Unit 7

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Reformer Tube Assembly (Objectives 3 and 4)
   TM 2—Design and Construction Notes (Objective 3)
   TM 3—Manufacturer's Drawing—Vessel (Objectives 3, 4, and 5)
   TM 4—Mechanical Flow Diagram—Vessel (Objectives 3, 4, and 5)
   TM 5—Mechanical Flow Diagram—Exchanger (Objective 5)
   TM 6—Manufacturer's Drawing—Exchanger (Objective 6)
   TM 7—Datum Dimensioning (Objectives 6 and 8)
   TM 8—Vessel Orientation (Objectives 7 and 8)
   TM 9—Mechanical Flow Diagram—Pumps (Objective 9)

5. Obtain films, videotapes, and other resources to supplement instruction of this unit. See ordering information in the Suggested Supplemental Resources section that follows.

6. Develop teaching plan. Adjust for different learning styles.

7. Make copies of the Unit Evaluation Form, which follows the written test section.

Delivery and Application

8. Provide students with unit of instruction.

9. Discuss unit and specific objectives.

Suggested Activities

10. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.

11. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Evaluation

12. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

13. Make copies of the written test. Add or modify test items as needed.

14. Give written test.

15. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment or job sheets.

16. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Take maximum advantage of the transparency masters. Use them to help students learn where to find things on a drawing, and the importance of looking for reference points when they interpret a drawing or placing proper references when they design or make drawings. Skill areas: **Learning skills, learning to learn.**

2. Talk to students about the importance of elevation dimensions and nozzle orientation in degrees. Students need to pay special attention to these items as they are present in Assignment Sheets 2 and 3. Students with basic match skills may require help in finding degrees for nozzle orientation. Skill areas: **Foundation skills, reading and math.**

3. Encourage students to complete Assignment Sheet 7 at a CAD workstation. Board exercises are great for beginners, but the sooner a student can do work with CAD, the more often the student should be encouraged to complete assignments at a CAD station. Skill areas: **Learning skills, learning to learn.**

Suggested Activities

4. Localize this unit by acquiring equipment fabrication drawings from a local drafting firm. Have students prepare BOMs and schedule of openings charts from the drawings. Forms to help students with this activity are presented in Student Supplement 3. Skill areas: **Foundation skills, reading and writing.**

Resources Used in Developing This Unit

1. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

2. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division/McGraw-Hill Book Co., 1981.

3. Weaver, Rip. *Process Piping Drafting*, 3rd ed. Houston, TX: Gulf Publishing Company, 1990.

4. Weaver, Rip. *Process Piping Drafting, Vols. 1 & 2*, 8th ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Supplemental Resources

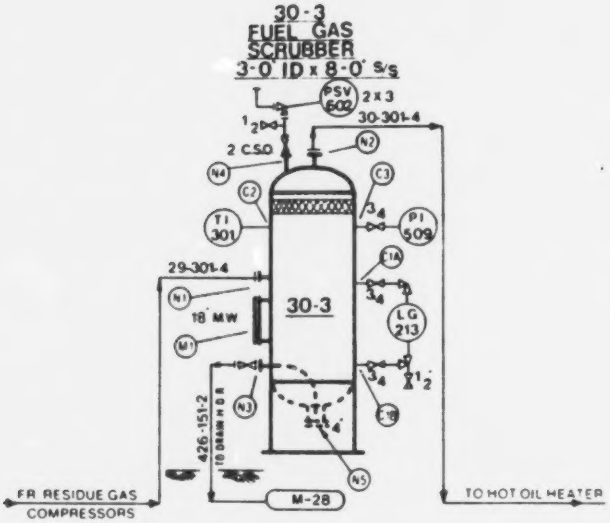
One or all eleven sections of the *ASME Boiler and Pressure Vessel Code* are available from the American Society of Mechanical Engineers. Call 1-800-843-2763 for information, or write:

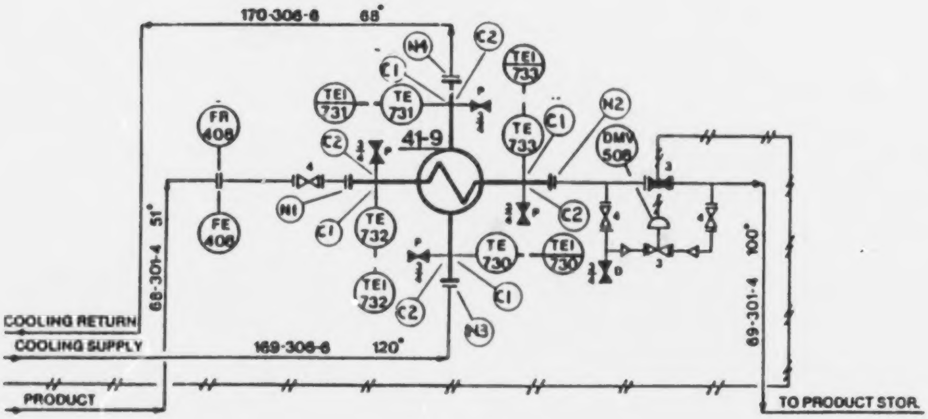
ASME
22 Law Drive
P.O. Box 2300
Fairfield, NJ 07007-2300

Equipment Fabrication Drawings
Unit 7

Answers to Assignment Sheets

Assignment Sheet 1


30-3
FUEL GAS
SCRUBBER
3-0 ID x 8-0 S/S
PSV 602
2 x 3
1/2
30-301-4
N2
2 CSO
N4
C2
C3
TI 301
3/4
PI 509
29-301-4
C1A
N1
30-3
18 MW
3/4
LG 213
M1
1/2
3/4
N3
C1B
426-151-2
10 DRAIN HDR
N5
FR. RESIDUE GAS COMPRESSORS
M-28
TO HOT OIL HEATER


170-306-6
68°
N4
C2
C1
TEI 733
TEI 731
TE 731
TE 733
C1
N2
FR 408
C2
41-9
DMV 508
4
3
N1
C2
C1
TE 732
FE 408
68-301-4
51°
TE 730
TEI 730
3
100°
69-301-4
TEI 732
C2
C1
N3
COOLING RETURN
COOLING SUPPLY
169-306-6
120°
PRODUCT
TO PRODUCT STOR.

516

Answers to Assignment Sheets

Assignment Sheet 2

a. 9′-3″
b. 3′-6″
c. 12′-9″
d. 12′-7″

Assignment Sheet 3

a. 45°
b. 180°
c. F.S.
d. N.S.
e. 0°

Assignment Sheet 4

a. Shell 100 Tube 150
b. Shell 150 Tube 225
c. 150°F
d. Jone Petroleum Co., Lee Plant, Hallet, Arkansas
e. 9,750#
f. 14,125#
g. W. W. Enterprises, Inc.

Assignment Sheet 5

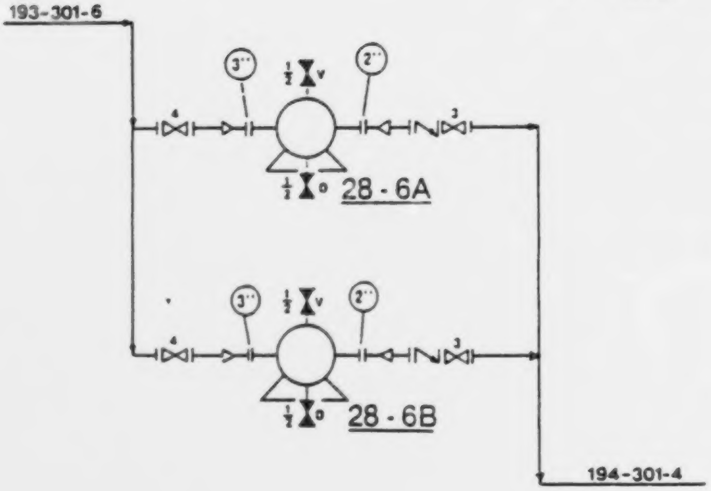
A	1	18″				ACCESS
C3	1	¾″	6000#	CPLG	1½″	PRESSURE INDICATOR
C2A/B	2	1″	6000#	CPLG	1½″	HIGH LEVEL ALARM
C1A/B	2	¾″	6000#	CPLG	1½″	LEVEL GAGE
M1	1	18″	600#	RFSO	10″	MANWAY W/DAVIT & BF
N5A/B	2	2″	600#	RFSO	8″	LEVEL CONTROLLER
N4	1	2″	600#	RFSO	TOP	(RELIEF) OUTLET
N3	1	2″	600#	RFSO	8″	DRAIN
N2	1	6″	600#	RFSO	8″	OUTLET
N1	1	6″	600#	RFSO	8″	INLET
MARK#	REQ'D	SIZE	RATING	TYPE	PROJ.	SERVICE

SCHEDULE OF OPENINGS

Answers to Assignment Sheets

Assignment Sheet 6

Top In	
a.	182T
b.	184T
c.	213T
d.	215T
e.	254T
f.	256T


193-301-6
4
3"
½ V
2"
3
½ D
28 - 6A
4
3"
½ V
2"
3
½ D
28 - 6B
194-301-4

Equipment Fabrication Drawings
Unit 7

Answers to Written Test

1. a. 3
   b. 5
   c. 10
   d. 12
   e. 9
   f. 13
   g. 7
   h. 1
   i. 4
   j. 8
   k. 11
   l. 2
   m. 6

2. a. 5
   b. 9
   c. 10
   d. 2
   e. 16
   f. 13
   g. 1
   h. 7
   i. 14
   j. 12
   k. 4
   l. 15
   m. 11
   n. 6
   o. 17
   p. 8
   q. 3

3. a. Design
   b. Operating
   c. Number
   d. Weight

4. b, c, d, f

5. a. Number, number
   b. N1
   c. Nozzle
   d. Other

6. a. Dimensioning
   b. Lower
   c. 2′
   d. Revolve

7. c

8. a, b, c

9. a. 3
   b. 1
   c. 2

10. a. (2)
    b. (1)

11. a, b, c, d, f

Equipment Fabrication Drawings
Unit 7

Written Test

Name ______________________________ Date ______________ Score _____

1. Match the terms on the right with their correct definitions.

_____a. A metal plate attached to the skirts of equipment and vessels to provide a transition piece from equipment to foundation

_____b. A method of joining two streams together

_____c. A screwed connection used primarily to attach smaller items to vessels

_____d. A method of dimensioning to a datum line (sometimes called tail dimensioning)

_____e. A line used as a reference for determining dimensions, usually from a point where a head attaches to a shell (datum line is also called a working line)

_____f. An externally mounted assembly used to hold manway doors or access covers when opened

_____g. A cover for one or both ends of vessels; a 2:1 elliptical head is the most common

_____h. Large nozzle and hinged flange on a vessel used to provide access to the inside of a vessel

_____i. A flanged projection opening into a vessel, used to attach larger items to a vessel

_____j. The distance from the outer part of a shell to the face of anything sticking out from a vessel

1. Manway
2. Skirt
3. Base plate
4. Nozzle
5. Connection
6. Specification
7. Head
8. Projection
9. Datum line
10. Coupling
11. Shell
12. Datum dimensioning
13. Davit

Written Test

______k. The main body of a vessel, pipe for smaller vessels, and rolled plate for larger vessels

______l. The supporting portion of a vertical vessel that extends from the vessel to the base plate and foundation

______m. Engineering information on a drawing to indicate what pressures, temperatures, and flows that a piece of equipment is sized for

2. Match equipment types with their applications. Place the number beside the equipment type in the blank that describes its application.

______a. Devices with tubes placed above large fans that use forced air for cooling, and are similar to automotive radiators (also called fin fans)

______b. Units with a fire box and a drum used to change water to steam power and/or to raise process temperature

______c. Exchangers that used a chilling medium to lower process temperature

______d. Used to increase the pressure of gases or liquids

______e. Structures with tubes inside that cool or condensate a product as water falls over the tubes

______f. A device that fractionates butane

______g. A device that fractionates isobutanes

______h. A device that fractionates propane

______i. Units used to transfer product temperature from one medium to another such as warming fluids for a process or condensing vapors

1. Deisodebutanizer
2. Compressors
3. Tanks
4. Heaters
5. Air coolers
6. Reflux accumulator
7. Depropanizer
8. Scrubbers
9. Boilers
10. Chillers
11. Reactor
12. Fractionation vessels
13. Debutanizer
14. Exchangers
15. Pumps
16. Cooling towers
17. Separators

Written Test

______j. Vertical towers (also called columns) used to add temperature to a product in order to change it to a different state of matter such as liquid to gas

______k. Heat exchanger units that use a firebox to increase product temperature

______l. Suction and force pumps used to propel liquid through a system

______m. A vessel, usually vertical, that contains a catalyst which causes a chemical change in the material being piped in, and the outlet usually goes to fractionation towers

______n. A usually overhead, horizontal vessel that accumulates the overhead products of the fractionators

______o. Used to separate a liquid from a gas or a liquid from a liquid during a process

______p. Used to remove liquids from a gas process

______q. Vertical and horizontal units used to store product or material needed for a process

3. Complete statements about information included on an equipment fabrication drawing. Circle the material that best completes each of the following statements.

   a. The (**design**) (**operating**) pressure and design temperature indicate maximum limits of performance and are related to limits of material types used in fabrication.

   b. The (**design**) (**operating**) pressure and temperature indicate actual operating parameters as determined from flow diagrams, and this should never exceed design pressure and temperature.

   c. Equipment should be named and identified with an equipment (**number**) (**description**).

   d. The (**size**) (**weight**) of the equipment is important information for fabrication and general handling and transportation.

Written Test

4. Select true statements about information found on a schedule of openings. Place an "X" beside each true statement.

______a. Each opening should list the service such as fluid, gas, etc., for which the opening will be used.

______b. The size and rating of each opening should be listed along with the type of connector each opening will use.

______c. Each opening must have a mark number for reference in points of manufacture and assembly.

______d. "N" stands for nozzle with N1 usually the inlet and N2 usually the outlet; other nozzle or flanged connections include drains, cleanouts, handholes, and others, and the mark N____ assigned.

______e. "A" usually marks assembly procedures.

______f. "C" signifies a coupling, usually with a 3000# or 6000# pressure rating, and these are used to connect monitoring equipment to vessels.

5. Complete statements about how to transfer information from a mechanical flow diagram to an equipment drawing. Circle the material that best completes each of the following statement.

a. Match the equipment (**code**) (**number**) on the mechanical flow diagram to the equipment (**code**) (**number**) on the equipment drawing (30-3).

b. Locate the inlet line on the mechanical flow diagram (29-301-4); this is usually given an (**N0**) (**N1**) mark on the equipment drawing.

c. Locate the (**inlet**) (**nozzle**) mark on the elevation and orientation views, and note the elevation dimension, datum, projection angle or orientation and angle datum location (0°).

d. Locate (**inlet**) (**outlet**) nozzle and other connections.

e. Use the procedure outlined to transfer information about heat exchangers, heaters, vessels, cooling towers, turbines, pumps, and all (**in-line**) (**other**) components.

Written Test

6. Complete statements about characteristics of datum dimensioning on elevation views. Circle the material that best completes each of the following statements.

   a. Datum dimensioning is used on manufacturers' drawings to avoid accumulative (**distortion**) (**dimensioning**) and lower the risk of manufacturing error.

   b. The datum line is usually located at the (**upper**) (**lower**) seam where the head is welded to the shell.

   c. The lower seam line to the base of the vessel is given in one full dimension such as (**1.5′**) (**2′**).

   d. Each (**component**) (**nozzle**) or connection has a datum dimension and sometimes an elevation dimension to grade.

   e. Nozzles and couplings are normally (**revolved**) (**isolated**) so they can be viewed in one elevation to aid in dimensioning.

7. Select true statements about characteristics of dimensioning on orientation views. Place an "X" beside each true statement.

   _______a. 0° is usually located at the bottom of an orientation view, and angles are usually CW.

   _______b. Most connections are located at 45°, 90°, 180°, and 225° to provide for manufacturing ease and speed.

   _______c. Level gauge connections are run vertical.

8. Select true statements about noting nozzle and coupling elevation, orientation, and projection. Place an "X" beside each true statement.

   _______a. Elevation, orientation, and projection of connections on vessels, tanks, and scrubbers are vital information for manufacture and assembly, and must be noted on equipment fabrication drawings.

   _______b. To calculate nozzle elevation, add the nozzle dimension, from the datum, to the base dimension.

   _______c. To dimension nozzle orientation, find the nozzle on the orientation view that you are working with, locate the 0° centerline, move in a CW direction, mark the degrees between the nozzle and 0° centerline.

   _______d. Projection dimensions of connections are usually noted beside each connection.

   _______e. Connections that do not run on a radial from the ℄ are normally dimensioned in the schedule of openings.

Written Test

9. Match types of pumps with their characteristics. Place the number beside the pump type in the blank beside the description of its characteristics.

______a. A type of pump used in 90% of pump installations because it requires little maintenance; these pumps must have a flooded suction, and liquid must not rise after leaving a vessel before entering a pump

______b. A pump that draws liquid into a cylinder on an intake stroke and forces out a discharge side with a compression stroke, much like the cylinder on a car; this pump requires dampening because each thrust causes a pulse in the piping, and joint fatigue, leaks, and pulsating flow are drawbacks to this type of pump

______c. A type of pump used to move heavy material like asphalt, grease, heavy fuel oil, or sludge; the most common pump of this type uses a screw which acts like an augur to push material

1. Reciprocating
2. Rotary
3. Centrifugal

10. Solve problems about selecting and sizing pumps. Circle the number beside the statement that best solves each of the following problems.

a. You've been working far too long trying to select and size a pump. To solve the problem, you need to:

(1) Review the service demands and make your decision.

(2) Look for the pump equipment symbol on the mechanical flow diagram because pump specifications are sometimes listed there.

(3) Consult the engineer or pump manufacturer so you can better match pump pressure, volume, rate of flow, and other important elements.

Written Test

b. You are trying to turn a sketch into an acceptable mechanical flow diagram, but you're having trouble sizing the pipe into and out of the pump. To solve your problem:

(1) Look for a difference in pipe sizes. The pipe into the pump, the inlet, should be larger than the pipe out or the discharge side of the pump.

(2) Redraw the materials and note any changes with the engineer.

(3) Look for notations that differentiate the "inlet" from the "outlet."

11. Select true statements about tubular heat exchanges. Place an "X" beside each true statement.

______a. In general, a tubular heat exchanger is sized according to size of shells and tube bundles as designated by numbers describing the shell and tube bundle diameters and tube length.

______b. Nominal diameter is the outside diameter of the shell in inches, rounded off to the nearest integer.

______c. For kettle reboilers, the nominal diameter is the port diameter followed by the shell diameter, each rounded off to the nearest integer.

______d. The type of heat exchanger is indicated by letters denoting front stationary head types, letters denoting shell types, and letters denoting rear end head types.

______e. The description of a heat exchanger should only list the type.

______f. Special designs may best be described as best suits the manufacturer.

***Permission to duplicate this test is granted.**

Equipment Fabrication Drawings
Unit 7

Teacher Supplement 1—BOM and Schedule of Openings for Knockout Pot

The Bill of Material and Schedule of Openings charts included here will help students with Objectives 4 and 8. You may reproduce these items as needed.

BILL OF MATERIAL

ITEM No.	QTY.	DESCRIPTION	MATERIAL
1	2	HEADS 36″ OD 2:1 ELLIP W/2″ SF	SA-516-7
		(ASME CODE F&D W/2″ S.F.)	
2	1	PL 3/16″ × 48″ × 112 1/2″ ROLL 3′-0″ O.D.	SA-516-7
3	2	8″ RFWN	SA-105
4	1	4″ RFWN	SA-105
5	2	2″ RFWN	SA-105
6	1	PIPE 8″ S/40 SMLS PIPE X 1′-7 1/8″ PBE	SA-106B
7	1	PIPE 8″ S/40 SMLS PIPE X 2′-0″ PBE	SA-106B
8	1	PIPE 4″ S/40 SMLS PIPE X 0′-8 1/4″ PBE	SA-106B
9	1	PIPE 2″ S/40 SMLS PIPE X 1′-1 7/8″ PBE	SA-106B
10	1	PIPE 2″ S/40 SMLS PIPE X 0′-2 7/16″ PBE	SA-105
11	1	1 1/2″ CPLG. 3000#	SA-105
12	1	1″ CPLG. 3000#	SA-105
13	2	3/4″ CPLG. 3000#	SA-105
14	1	4″ BLIND FLANGE 150#	SA-105
15	1	2″ BLIND FLANGE 150#	SA-105
16	1	1″ HEX PLUG 6000#	
17	1	2″ STRAIGHT TEE 160#	
18	3	1/2″ PL 4×4″ BASE PLATE	A-36
19	3	3 × 3 × 3/8 < X 2′-11 1/2″	A-36
20	3	3/8″ PL 3 × 3 TRIM TO FIT CAP	SA-105
21	1	ELBOW 90′ 8″ LR 150#	

Teacher Supplement 1

SCHEDULE OF OPENINGS

MARK	No REQ'D	SIZE	RATING	TYPE	FLANGE	NECK	COVER	BOLTS	GASKET	PAD	THO-O-LET	CPLG.	FITTING	O.D. × THK	MAT'L	SCH	WALL	MAT'L	O.S.	L.S.	WELD DETAIL DWG.		a	b	c	SERVICE
					MATERIAL LIST NO									REPAD		NECK			PROJ				WELD SIZE			
C3	1	1½"	3000#	CPLG.								11						SA-105		.375	10					LEVEL SWITCH
C2A	1	¾"	3000#	CPLG.								13						SA-105		.375	10					LEVEL GA
C2B	1	¾"	3000#	CPLG.								13						SA-105		.375	10					LEVEL GA
C1	1	1"	3000#	CPLG.								12	16					SA-105		.375	10					VENT
N4	1	2"	150#	RFWN	5	10	15						17			STD	.154	SA-106-B		.375	1	5	3/16	3/16		CLEAN OUT
N2	1	8"	150#	RFWN	3	6							21			STD	.322	SA-106-B		.375	1	5	3/16	3/16		OUTLET
M1	1	4"	150#	RFWN	4	8	14									STD	.237	SA-106-B		.375	1	5	3/16	3/16		HANDHOLE
F	1	2"	150#	RFWN	5	9										STD	.154	SA-106-B		.375	1	5	3/16	3/16		DRAIN
A	1	8"	150#	RFWN	3	7										STD	.322	SA-106-B		.375	1	5	3/16	3/16		INLET

SCHEDULE OF OPENINGS

Equipment Fabrication Drawings
Unit 7

Unit Evaluation Form

Student Name ______________________ Unit Rating __________

Assignment Sheet 1—Locate Correct Nozzle Mark Numbers on Mechanical Flow Diagram Rating ______

Comments: ______________________

____

Assignment Sheet 2—Calculate Nozzle Elevation Dimensions From Given Mark Numbers on a Drawing Rating ______

Comments: ______________________

____

Assignment Sheet 3—Calculate Nozzle Orientation in Degrees From Given Mark Numbers on a Drawing Rating ______

Comments: ______________________

____

Assignment Sheet 4—Locate Information on a Drawing Rating ______

Comments: ______________________

____

Assignment Sheet 5—Prepare a Schedule of Openings Chart From a Mechanical Flow Diagram Rating ______

Comments: ______________________

____

Assignment Sheet 6—Find Correct Nozzle Sizes From a Pump Specification Sheet on a Mechanical Flow Chart Rating ______

Comments: ______________________

____

Unit Evaluation Form

Assignment Sheet 7—Draw a Steam Drum Layout Rating ______

Comments: ____

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ____

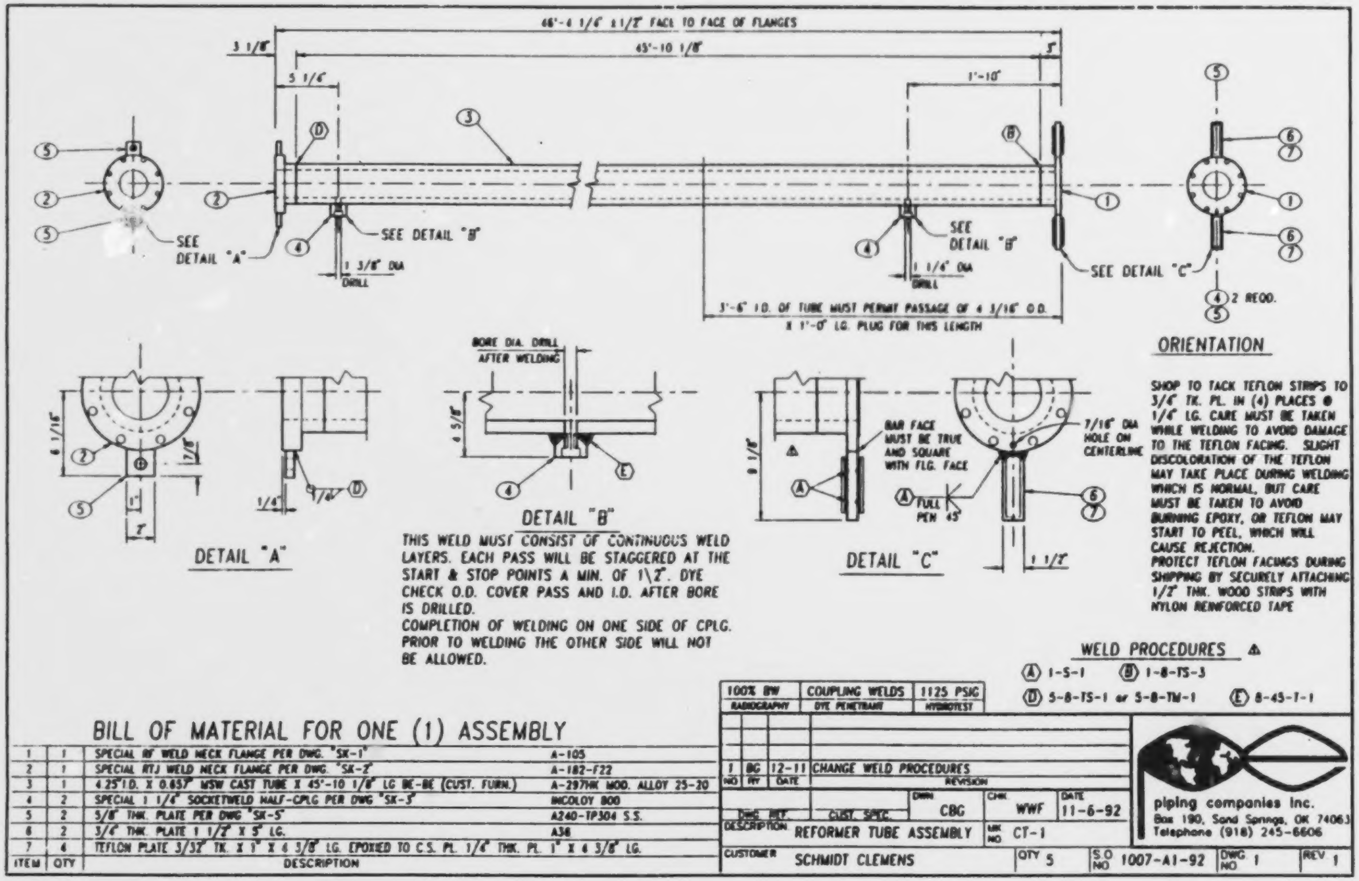
____

Teacher Signature ______________________ Date __________

Student Signature ______________________ Date __________

***Permission to duplicate this form is granted.**

Reformer Tube Assembly


46'-4 1/4" ±1/2" FACE TO FACE OF FLANGES
3 1/8"
45'-10 1/8"
3"
5 1/4"
1'-10"
⑤
②
⑤
SEE DETAIL "A"
②
Ⓓ
③
④
SEE DETAIL "B"
1 3/8" DIA DRILL
Ⓑ
④
SEE DETAIL "B"
1 1/4" DIA DRILL
①
SEE DETAIL "C"
⑤
⑥
⑦
①
⑥
⑦
④ 2 REQD.
⑤
3'-6" I.D. OF TUBE MUST PERMIT PASSAGE OF 4 3/16" O.D. X 1'-0" LG. PLUG FOR THIS LENGTH
ORIENTATION
6 1/16"
7/8"
②
⑤
1"
2"
1/4"
1/4"
Ⓓ
DETAIL "A"
BORE DIA. DRILL AFTER WELDING
4 5/8"
④
Ⓔ
DETAIL "B"
8 1/8"
Ⓐ
BAR FACE MUST BE TRUE AND SQUARE WITH FLG. FACE
Ⓐ FULL PEN 45°
7/16" DIA HOLE ON CENTERLINE
⑥
⑦
1 1/2"
DETAIL "C"

THIS WELD MUST CONSIST OF CONTINUOUS WELD LAYERS. EACH PASS WILL BE STAGGERED AT THE START & STOP POINTS A MIN. OF 1\2". DYE CHECK O.D. COVER PASS AND I.D. AFTER BORE IS DRILLED.

COMPLETION OF WELDING ON ONE SIDE OF CPLG. PRIOR TO WELDING THE OTHER SIDE WILL NOT BE ALLOWED.

SHOP TO TACK TEFLON STRIPS TO 3/4" TK. PL. IN (4) PLACES @ 1/4" LG. CARE MUST BE TAKEN WHILE WELDING TO AVOID DAMAGE TO THE TEFLON FACING. SLIGHT DISCOLORATION OF THE TEFLON MAY TAKE PLACE DURING WELDING WHICH IS NORMAL, BUT CARE MUST BE TAKEN TO AVOID BURNING EPOXY, OR TEFLON MAY START TO PEEL, WHICH WILL CAUSE REJECTION.

PROTECT TEFLON FACINGS DURING SHIPPING BY SECURELY ATTACHING 1/2" THK. WOOD STRIPS WITH NYLON REINFORCED TAPE

WELD PROCEDURES △

Ⓐ 1-5-1
Ⓑ 1-8-TS-3
Ⓓ 5-8-TS-1 or 5-8-TM-1
Ⓔ 8-45-T-1

BILL OF MATERIAL FOR ONE (1) ASSEMBLY

ITEM	QTY	DESCRIPTION	
1	1	SPECIAL RF WELD NECK FLANGE PER DWG. "SK-1"	A-105
2	1	SPECIAL RTJ WELD NECK FLANGE PER DWG. "SK-2"	A-182-F22
3	1	4.25" I.D. X 0.657" MSW CAST TUBE X 45'-10 1/8" LG BE-BE (CUST. FURN.)	A-297HK MOD. ALLOY 25-20
4	2	SPECIAL 1 1/4" SOCKETWELD HALF-CPLG PER DWG "SK-3"	INCOLOY 800
5	2	5/8" THK. PLATE PER DWG "SK-5"	A240-TP304 S.S.
6	2	3/4" THK. PLATE 1 1/2" X 5" LG.	A36
7	4	TEFLON PLATE 3/32" TK. X 1" X 4 3/8" LG. EPOXIED TO C.S. PL. 1/4" THK. PL. 1" X 4 3/8" LG.	

RADIOGRAPHY	DYE PENETRANT	HYDROTEST
100% BW	COUPLING WELDS	1125 PSIG

NO	BY	DATE	REVISION
1	BG	12-11	CHANGE WELD PROCEDURES

DWG. REF.	CUST. SPEC.	DWN	CHK	DATE
		CBG	WWF	11-6-92

DESCRIPTION REFORMER TUBE ASSEMBLY
MK NO CT-1
CUSTOMER SCHMIDT CLEMENS
QTY 5
S.O NO 1007-A1-92
DWG NO 1
REV 1

piping companies inc.
Box 190, Sand Springs, OK 74063
Telephone (918) 245-6606

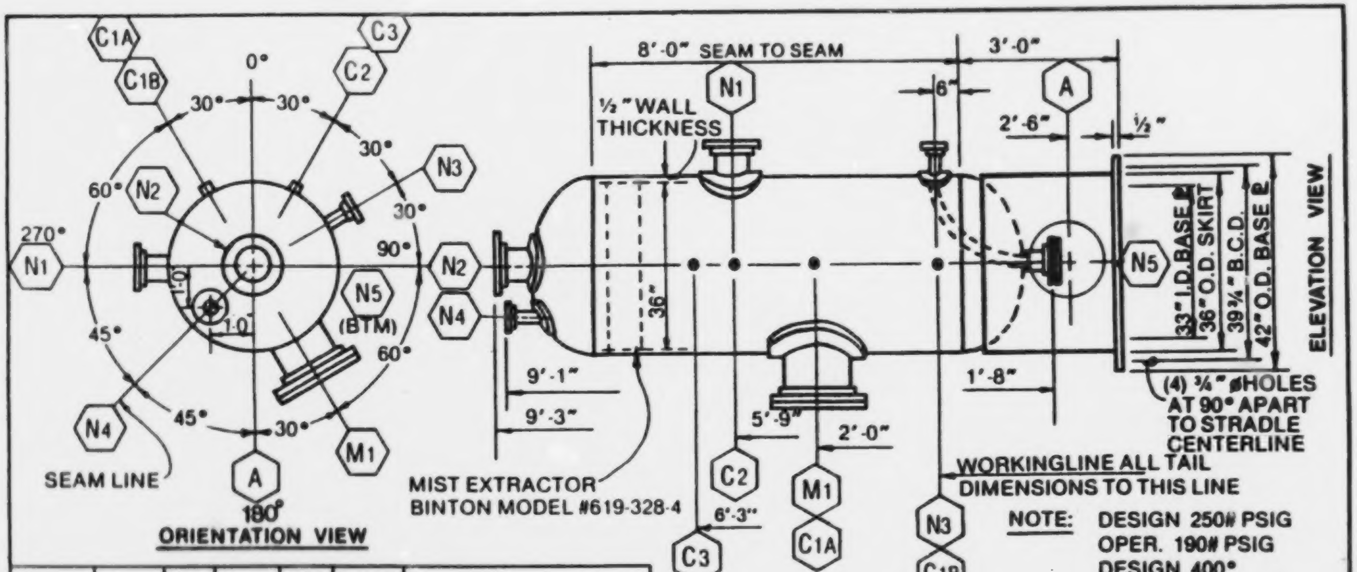
Design and Construction Notes

1. DESIGN 1989 ASME, SECT. VIII, DIV 1 ADDENDUM LATEST
2. STRESS RELIEVING NONE REQ'D
3. RADIOGRAPHING SPOT REQ'D
4. JOINT EFF: HEADS: 85 % SHELL LONG: 85 % HEAD/SHELL: 85 %
5. CORROSION ALLOWANCE: 1/16"
6. ULTRASONIC TESTING NONE
7. DESIGN PRESSURE: 15 P.S.I.G. 250° F
   EXTERNAL _______ P.S.I.G. _______

MATERIAL AND INSPECTION NOTES

8. HEADS: SA-516-70 ASME CODE F & D W7 2" S.F.
9. SHELL: SA-516-70
10. REINFORCING: SA-516-70
11. SKIRT: N/A
12. BASE PLATE: A-36
13. STRUCTURAL: A-36
14. NOZZLES: A. FLANGES: SA-105 B. COVERS: SA-105 C. NECKS: SA-106B
15. COUPLINGS/THREADOLETS: SA-105
16. PRESSURE BOLTING: STUDS: SA-193-B7 NUTS: SA-194-2H
17. NON-PRESSURE BOLTING: A-307 2 INC PL
18. GASKETS: NON-ASB
19. INTERNALS: _______
20. FLG. BOLT HOLES TO STRADDLE NORMAL VESSEL UNLESS NOTED.
21. EACH NOZ & MANHOLE REINF. PAD OR SEGMENT THEREOF TO HAVE ONE 1/4" P.T.T. HOLE LOCATED 90° OFF LONGITUDINAL AXIS.
22. VESSEL SHALL BE CLEANED INSIDE AND OUTSIDE, FREE OF DIRT, GREASE, LOOSE MILL SCALE, WELD SPATTER, ETC.
23. INSTALL WOOD OR STEEL COVERS ON ALL OPENINGS BEFORE SHIPMENT.
24. PROTECT ALL MACHINED SURFACES AND THREADED CONNECTIONS WITH A RUST PREVENTATIVE GREASE PRIOR TO SHIPMENT.
25. VESSEL FINISH: F.X.T.C.S. SANDBLAST/SSPC.SP-6
26. PAINT CARBOZINC II (GRAY) (2-4 MILS D.F.T.)
27. TAG NO'S TO BE PRECEDED BY CALLIDUS JOB NO.
28. MTR'S REQ'D ON ALL MATERIAL.
29. BUTTWELDS TO BE FULL PENETRATION, FILLET WELD TO BE 3/16" MIN UNLESS NOTED OTHERWISE.

Manufacturer's Drawing—Vessel


C1A
C3
C1B
C2
0°
30°
30°
30°
N3
30°
60°
N2
270°
N1
90°
N2
N5
(BTM)
N4
1'-0"
1'-0"
45°
60°
45°
30°
N4
M1
SEAM LINE
A
180°
ORIENTATION VIEW
8'-0" SEAM TO SEAM
3'-0"
N1
6"
A
½" WALL THICKNESS
2'-6"
½"
36"
N5
33" I.D. BASE ℄
36" O.D. SKIRT
39¾" B.C.D.
42" O.D. BASE ℄
ELEVATION VIEW
9'-1"
9'-3"
1'-8"
(4) ¾" ⌀ HOLES AT 90° APART TO STRADLE CENTERLINE
5'-9"
2'-0"
MIST EXTRACTOR BINTON MODEL #619-328-4
C2
M1
WORKINGLINE ALL TAIL DIMENSIONS TO THIS LINE
6'-3"
C3
C1A
N3
C1B

NOTE:
DESIGN 250# PSIG
OPER. 190# PSIG
DESIGN 400°
OPER. 125° TEMP
PAINT NONE
WT DRY 4800
WT WET 9629

THIS VESSEL BUILT & DESIGNED TO NATIONAL BOARD CODE & ASME SEC.VII DIV 177ED & ADDENDA

REINFORCEMENT PADS ON ALL OPENINGS 2" AND LARGER

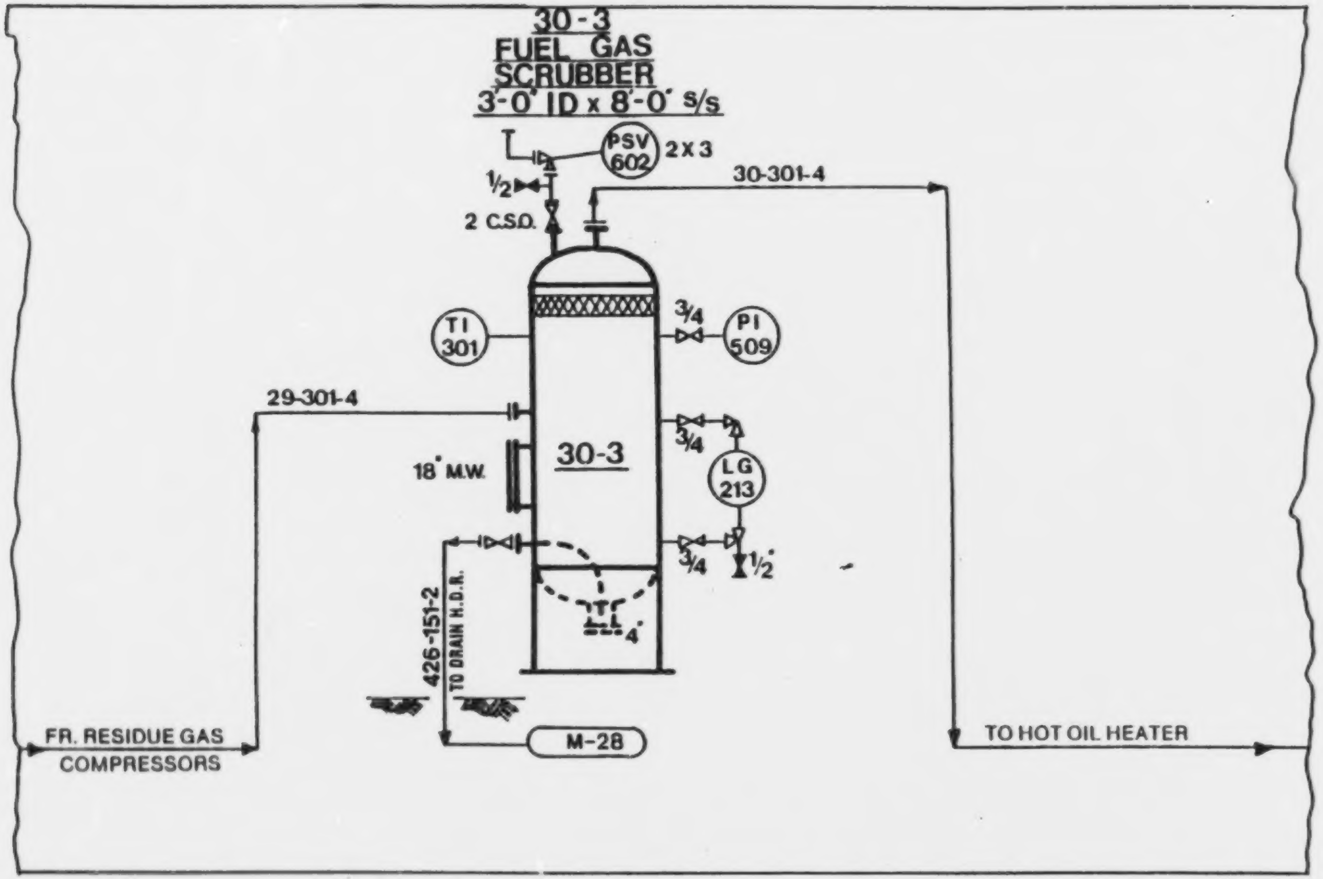
MARK#	REQ'D	SIZE	RATING	TYPE	PROJ.	SERVICE
C 3	1	3/4	6000#	CPLG	1 1/2	PRESSURE INDICATOR
C 2	1	3/4	6000#	CPLG	1 1/2	TEMPERATURE INDICATOR
C 1AB	2	3/4	6000#	CPLG	1 1/2	LEVEL GAUGE
A	1	18	—	—	—	ACCESS
M 1	1	18	300#	RFSO	10"	MANWAY W/BLIND AND DAVIT
N 5	1	4	300#	RFSO	BOTTOM	CLEANOUT
N 4	1	2	300#	RFSO	TOP SIDE	OUTLET (RELIEF)
N 3	1	2	300#	RFSO	8	SIPHON DRAIN
N 2	1	4	300#	RFSO	TOP	OUTLET
N 1	1	4	300#	RFSO	8"	INLET

SCHEDULE OF OPENINGS

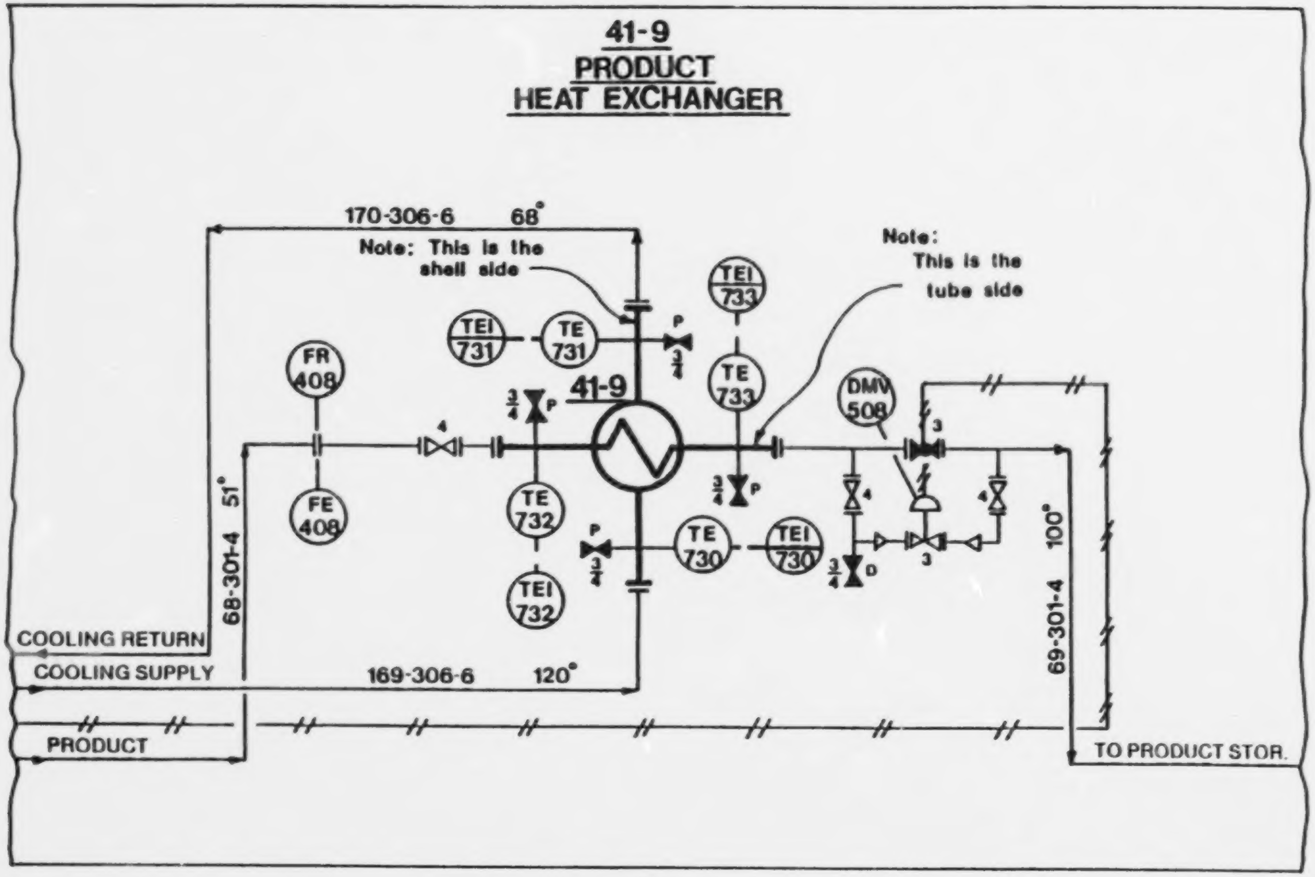
ITEM NO. 30-3
P.O. NO. 2957-018
SERIAL NO. 6497
NAT'L BOARD NO. LATER
CUSTOMER B DOE OIL CO.

MOSQUITO MFG. CO.
CENTRAL PACIFIC OCEAN
SCALE: NONE
DRAWN BY: J. DOE
DATE: 7/9/82
APPR. BY:
FUEL GAS SCRUBBER
JOB 4949-2
DRAWING NO.31611-5

Mechanical Flow Diagram—Vessel


30-3
FUEL GAS
SCRUBBER
3'-0" ID x 8'-0" s/s
PSV
602
2 X 3
1/2
2 C.S.O.
30-301-4
TI
301
3/4
PI
509
29-301-4
18" M.W.
30-3
3/4
LG
213
3/4
1/2"
4"
426-151-2
TO DRAIN H.D.R.
M-28
FR. RESIDUE GAS
COMPRESSORS
TO HOT OIL HEATER

Mechanical Flow Diagram—Exchanger


41-9
PRODUCT
HEAT EXCHANGER
170-306-6 68°
Note: This is the shell side
Note: This is the tube side
TEI 731
TE 731
TEI 733
TE 733
FR 408
FE 408
41-9
DMV 508
TE 732
TEI 732
TE 730
TEI 730
68-301-4 51°
69-301-4 100°
COOLING RETURN
COOLING SUPPLY
169-306-6 120°
PRODUCT
TO PRODUCT STOR.

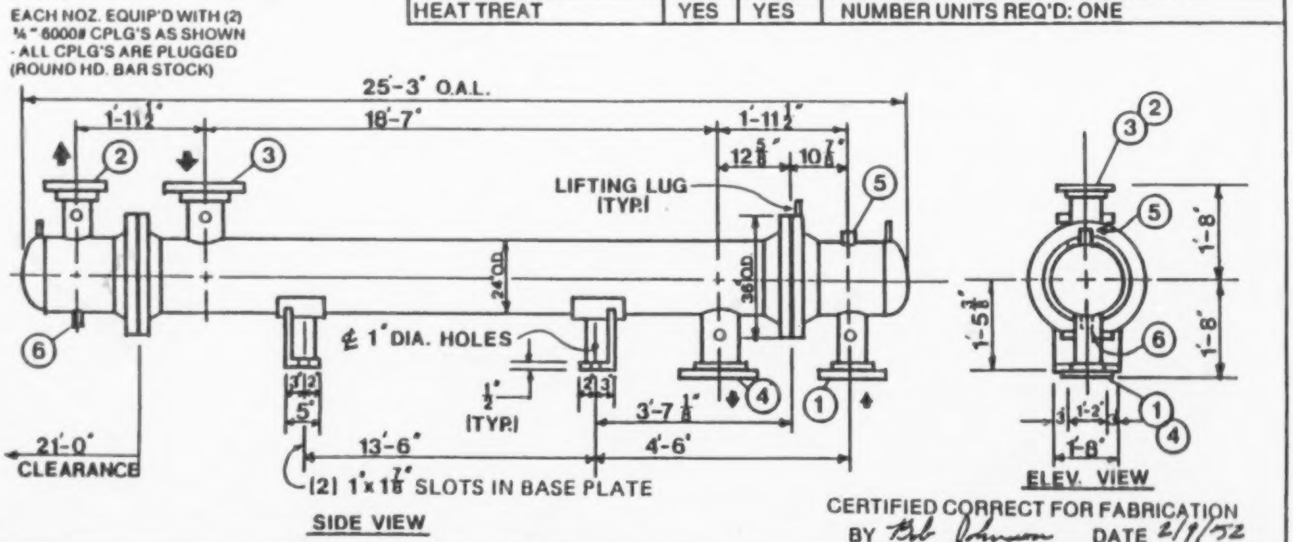
Pipe Drafting With CAD, Unit 7
Teacher Page 31

TM 5

Manufacturer's Drawing—Exchanger

MK	NOZZLE	SIZE - SERIES
1	TUBE OUTLET	4"-300# RFSO
2	TUBE OUTLET	4"-300# RFSO
3	SHELL INLET	6"-300# RFSO
4	SHELL OUTLET	6"-300# RFSO
5	VENT	3/4 "-6000# CPLG
6	DRAIN	3/4 "-6000# CPLG

DESCRIPTION	SHELL	TUBE	CUSTOMER:MAVCC ENG. CO.
DESIGN PRESS (PSI)	100	150	DESTINATION :JONES PET.CO. LEE PLANT
TEST PRESS (PSI)	150	225	HALLET, ARKANSAS
DESIGN TEMP (°F)	150	150	PURCHASE ORDER #6247-019
CORROSION ALLOW (In.)	1/8"	1/8"	CUST.ITEM #A-6238-421-15-6(6247-41-9) ←
NUMBER PASSES	ONE	ONE	SERVICE: PRODUCT HEAT EXCHANGER
RADIOGRAPH	NO	SPOT	WEIGHT: DRY 9,750# WET 14,125#
HEAT TREAT	YES	YES	NUMBER UNITS REQ'D: ONE


EACH NOZ. EQUIP'D WITH (2) ¾" 6000# CPLG'S AS SHOWN - ALL CPLG'S ARE PLUGGED (ROUND HD. BAR STOCK)
25'-3" O.A.L.
1'-11½"
18'-7"
1'-11½"
12⅝"
10⅞"
LIFTING LUG (TYP.)
②
③
⑤
⑥
24" O.D.
36" O.D.
℄ 1" DIA. HOLES
½" (TYP.)
3'-7⅛"
④
①
3 | 2
5"
2 | 3
21'-0" CLEARANCE
13'-6"
4'-6"
(2) 1" x 1⅞" SLOTS IN BASE PLATE
SIDE VIEW
1'-8"
1'-8"
1'-5⅜"
1'-2"
1'-8"
ELEV. VIEW

CERTIFIED CORRECT FOR FABRICATION
BY Bob Johnson DATE 2/9/52

NOTES:
1. ALL BOLTS HOLES TO STR. ℄'S
2. PAINT;SANDBLAST & PAINT WITH (1)COAT OF DUPONT PRIMER # 825-8031 (3) MILS. (MIN.) D.F.T.

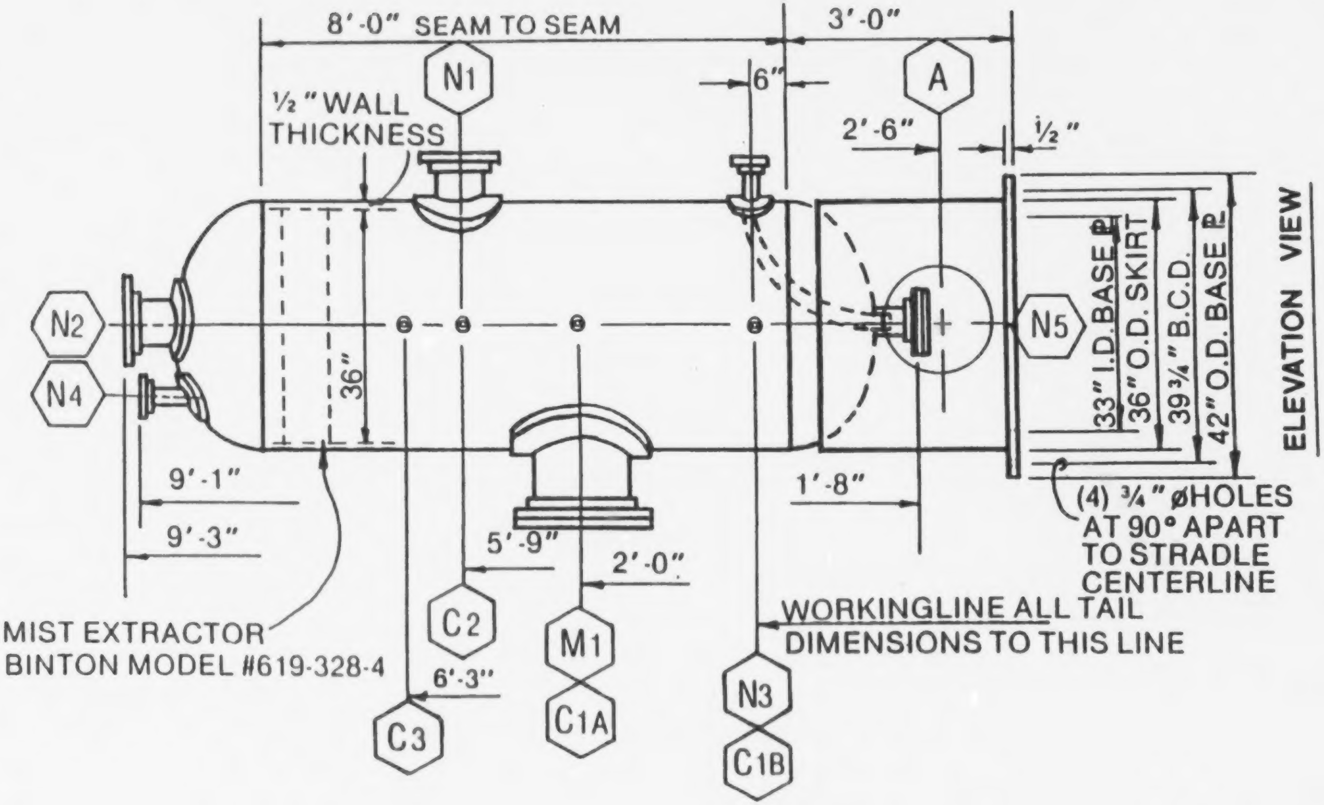
REV	DATE	DESCRIPTION
3		
2		
1	3/6/52	GEN COST REV

REVISIONS

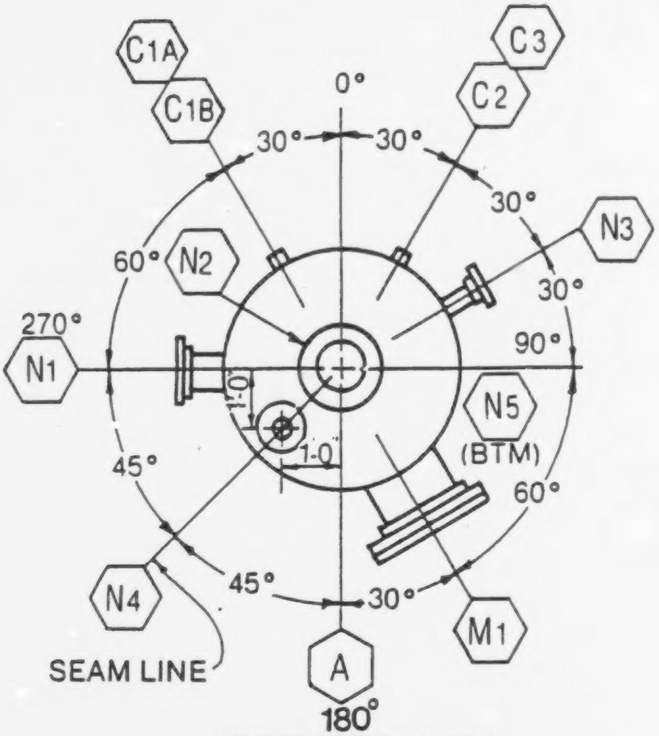
W.W. ENTERPRISES, INC.
Tulsa, Okla.

DATE 2/3/52	BY DV	DWG NO.1048-2-1
SCALE NONE	TYPE BEM	APPR P ⚠1

Datum Dimensioning


8'-0" SEAM TO SEAM
3'-0"
N1
6"
A
½ " WALL THICKNESS
2'-6"
½ "
N2
N4
N5
36"
33" I.D. BASE ℄
36" O.D. SKIRT
39¾" B.C.D.
42" O.D. BASE ℄
ELEVATION VIEW
9'-1"
9'-3"
1'-8"
(4) ¾" øHOLES AT 90° APART TO STRADLE CENTERLINE
5'-9"
2'-0"
C2
M1
WORKINGLINE ALL TAIL DIMENSIONS TO THIS LINE
MIST EXTRACTOR BINTON MODEL #619-328-4
6'-3"
C3
C1A
N3
C1B

Vessel Orientation

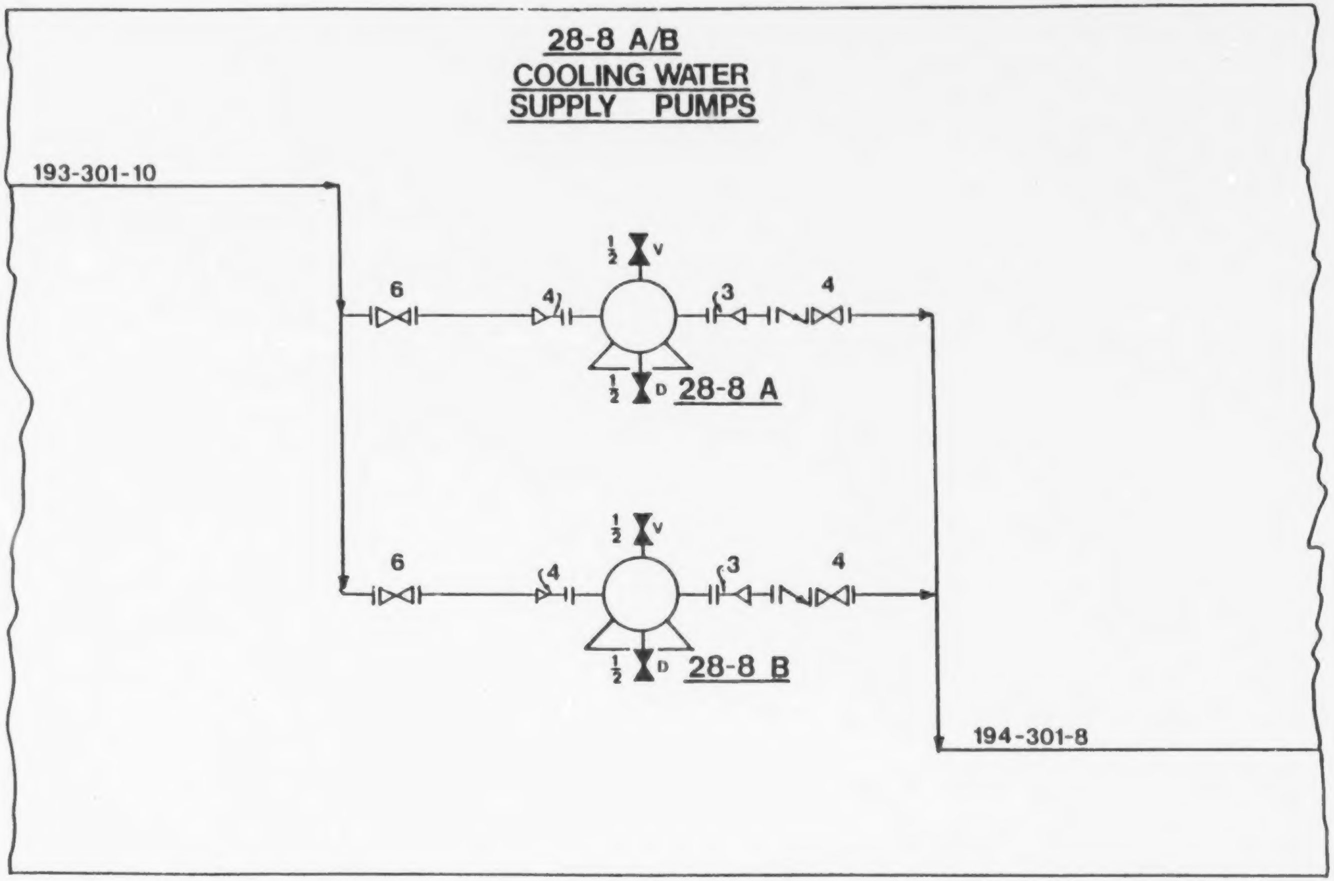

C1A
C1B
C3
C2
0°
30°
30°
30°
N3
30°
60°
N2
270°
90°
N1
1'-0"
N5
(BTM)
1'-0"
45°
60°
N4
45°
30°
M1
SEAM LINE
A
180°

ORIENTATION VIEW

C 3	1	3/4	6000#	CPLG	1 1/2	PRESSURE INDICATOR
C 2	1	3/4	6000#	CPLG	1 1/2	TEMPERATURE INDICATOR
C 1AB	2	3/4	6000#	CPLG	1 1/2	LEVEL GAUGE
A	1	18	——	——	——	ACCESS
M 1	1	18	300#	RFSO	10"	MANWAY W/BLIND AND DAVIT
N 5	1	4	300#	RFSO	BOTTOM	CLEANOUT
N 4	1	2	300#	RFSO	TOP SIDE	OUTLET (RELIEF)
N 3	1	2	300#	RFSO	8	SIPHON DRAIN
N 2	1	4	300#	RFSO	TOP	OUTLET
N 1	1	4	300#	RFSO	8"	INLET
MARK#	***REQ'D***	***SIZE***	***RATING***	***TYPE***	***PROJ.***	***SERVICE***

SCHEDULE OF OPENINGS

Mechanical Flow Diagram—Pumps


28-8 A/B
COOLING WATER
SUPPLY PUMPS
193-301-10
½
V
6
4
3
4
½
D
28-8 A
½
V
6
4
3
4
½
D
28-8 B
194-301-8

Pipe Drafting With CAD, Unit 7
Teacher Page 39

TM 9

Equipment Fabrication Drawings
Unit 7

Information Sheet

1. **Terms and definitions**

   a. **Base plate** — A metal plate attached to the skirts of equipment and vessels to provide a transition piece from equipment to foundation

   b. **Connection** — A method of joining two streams together

   c. **Coupling** — A screwed connection used primarily to attach smaller items to vessels

   d. **Datum dimensioning** — A method of dimensioning to a datum line (sometimes called tail dimensioning)

   e. **Datum line** — A line used as a reference for determining dimensions, usually from a point where a head attaches to a shell (datum line is also called a working line)

   f. **Davit** — An externally mounted assembly used to hold manway doors or access covers when opened

   g. **Head** — A cover for one or both ends of vessels; a 2:1 elliptical head is the most common

   h. **Manway** — Large nozzle and hinged flange on a vessel used to provide access to the inside of a vessel

   i. **Nozzle** — A flanged projection opening into a vessel, used to attach larger items to a vessel

   j. **Projection** — The distance from the outer part of a shell to the face of anything sticking out from a vessel

   k. **Shell** — The main body of a vessel, pipe for smaller vessels, and rolled plate for larger vessels

   l. **Skirt** — The supporting portion of a vertical vessel that extends from the vessel to the base plate and foundation

   m. **Specification** — Engineering information on a drawing to indicate what pressures, temperatures, and flows that a piece of equipment is sized for

Information Sheet

2. Equipment types and applications

a. **Air coolers** — Devices with tubes placed above large fans that use forced air for cooling, and are similar to automotive radiators (also called fin fans)

b. **Boilers** — Units with a fire box and a drum used to change water to steam power and/or to raise process temperature

c. **Chillers** — Exchangers that used a chilling medium to lower process temperature

d. **Compressors** — Used to increase the pressure of gases or liquids

e. **Cooling towers** — Structures with tubes inside that cool or condensate a product as water falls over the tubes

f. **Debutanizer** — A device that fractionates butane

g. **Deisodebutanizer** — A device that fractionates isobutanes

h. **Depropanizer** — A device that fractionates propane

i. **Exchangers** — Units used to transfer product temperature from one medium to another such as warming fluids for a process or condensing vapors

j. **Fractionation vessels** — Vertical towers (also called columns) used to add temperature to a product in order to change it to a different state of matter such as liquid to gas

k. **Heaters** — Heat exchanger units that use a firebox to increase product temperature

l. **Pumps** — Suction and force pumps used to propel liquid through a system

m. **Reactor** — A vessel, usually vertical, that contains a catalyst which causes a chemical change in the material being piped in, and the outlet usually goes to fractionation towers

Information Sheet

n. **Reflux accumulator** — A usually overhead, horizontal vessel that accumulates the overhead products of the fractionators

Note: Reflux accumulators have few or no internal baffles.

o. **Separators** — Used to separate a liquid from a gas or a liquid from a liquid during a process

p. **Scrubbers** — Used to remove liquids from a gas process

q. **Tanks** — Vertical and horizontal units used to store product or material needed for a process

3. Information included on an equipment fabrication drawing

a. The design pressure and design temperature indicate maximum limits of performance and are related to limits of material types used in fabrication.

b. The operating pressure and temperature indicate actual operating parameters as determined from flow diagrams, and this should never exceed design pressure and temperature.

c. Equipment should be named and identified with an equipment number.

d. The weight of the equipment is important information for fabrication and general handling and transportation.

Note: Many more items may appear on an equipment fabrication drawing, and the number of items included generally depend on the sophistication of the product.

GENERAL SPECIFICATIONS

CONSTRUCTION TO BE IN ACCORDANCE WITH THE LATEST EDITION OF THE 1990 ASME CODE SEC. VIII DIV. 1
CODE STAMP REQ'D YES   OTHER SPECS
DESIGN PRESSURE 15   PSIG • TEMPERATURE 250 °F
OPERATING PRESSURE 15   PSIG • TEMPERATURE -20 °F
MAX. A.W.P.   PSIG LIMITED BY   CORROSION ALLOWANCE 1/16"
JOINT EFFICIENCY: HEADS 85% SHELL 85%   HEADS & SHELL 85%
RADIOGRAPH SPOT   STRESS RELIEVE NO   HYDRO TEST PSIG 23
SANDBLAST
PAINT SEE NOTE 26
EST. WT. EMPTY   LBS.   EST. WT. FULL/WATER   LBS.
JOB No.   NATIONAL BOARD No.
IMPACT TEST EXEMPT PER UG-20F

Information Sheet

4. Information on a schedule of openings

a. Each opening should list the service such as inlet, outlet, or pressure indicator for which the opening will be used.

b. The size and rating of each opening should be listed along with the type of connector each opening will use.

Examples: CPLG = COUPLING, RFSO = RAISED FLANGE SLIP ON, and RFWN = RAISED FLANGE WELD NECK

c. Each opening must have a mark number for reference in points of manufacture and assembly.

C_3	1	3/4	6000#	CPLG	1 1/2	PRESSURE INDICATOR
C_2	1	3/4	6000#	CPLG	1 1/2	TEMPERATURE INDICATOR
C_{1AB}	2	3/4	6000#	CPLG	1 1/2	LEVEL GAUGE
A	1	18	—	—	—	ACCESS
M_1	1	18	300#	RFSO	10"	MANWAY W/BLIND AND DAVIT
N_5	1	4	300#	RFSO	BOTTOM	CLEANOUT
N_4	1	2	300#	RFSO	TOP SIDE	OUTLET (RELIEF)
N_3	1	2	300#	RFSO	8	SIPHON DRAIN
N_2	1	4	300#	RFSO	TOP	OUTLET
N_1	1	4	300#	RFSO	8"	INLET
MARK#	*REQ'D*	*SIZE*	*RATING*	*TYPE*	*PROJ.*	*SERVICE*

SCHEDULE OF OPENINGS

d. "N" stands for nozzle with N1 usually the inlet and N2 usually the outlet; other nozzle or flanged connections include drains, cleanouts, handholes, and others, and the mark N____ assigned.

e. "A" usually marks access holes through the skirts of vertical vessels.

f. "C" signifies a coupling, usually with a 3000# or 6000# pressure rating, and these are used to connect monitoring equipment to vessels.

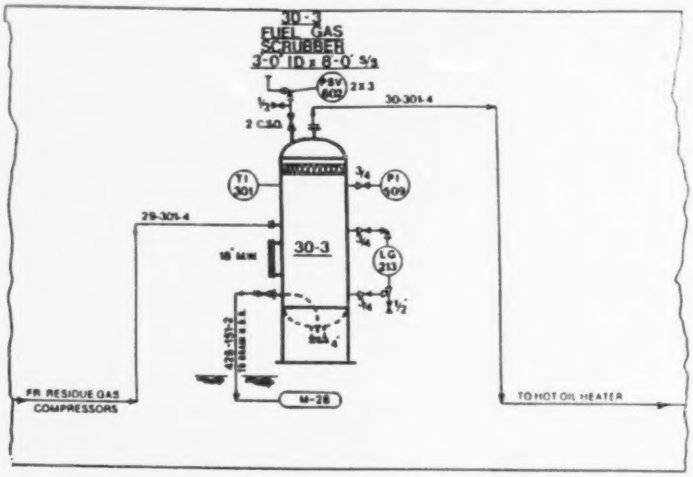
Note: The high pressure rating on couplings is to insure minimal thread distortion when a coupling is welded to a vessel.

Information Sheet

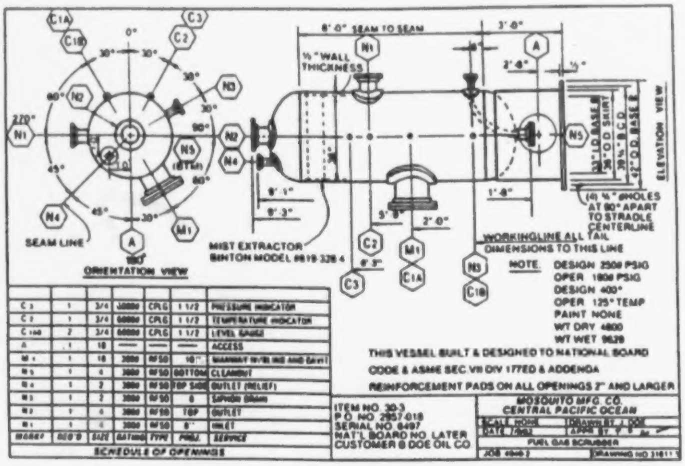
5. **How to transfer information from a mechanical flow diagram to an equipment drawing**

   a. Match the equipment number on the mechanical flow diagram to the equipment number on the equipment drawing (30-3).

   b. Locate the inlet line on the mechanical flow diagram (29-301-4); this is usually given an N1 mark on the equipment drawing.


30-3
FUEL GAS
SCRUBBER
3'-0" ID x 8'-0" S/S
PSV 602
2x3
30-301-4
2 CSO
TI 301
PI 309
29-301-4
30-3
LG 213
FR RESIDUE GAS
COMPRESSORS
M-28
TO HOT OIL HEATER

   c. Locate the nozzle mark on the elevation and orientation views, and note the elevation dimension, datum, projection angle or orientation and angle datum location (0°).


0°
270°
180°
SEAM LINE
ORIENTATION VIEW
8'-0" SEAM TO SEAM
3'-0"
½" WALL THICKNESS
ELEVATION VIEW
MIST EXTRACTOR
BINTON MODEL #819-328-4
(4) ¾" ⌀HOLES AT 90° APART TO STRADLE CENTERLINE
WORKINGLINE ALL TAIL DIMENSIONS TO THIS LINE
NOTE: DESIGN 2500 PSIG
OPER 1800 PSIG
DESIGN 400°
OPER 125° TEMP
PAINT NONE
WT DRY 4800
WT WET 9620
THIS VESSEL BUILT & DESIGNED TO NATIONAL BOARD
CODE & ASME SEC VIII DIV 1 77ED & ADDENDA
REINFORCEMENT PADS ON ALL OPENINGS 2" AND LARGER
ITEM NO 30-3
P O NO 2957-018
SERIAL NO 6497
NAT'L BOARD NO LATER
CUSTOMER B DOE OIL CO
MOSQUITO MFG. CO.
CENTRAL PACIFIC OCEAN
FUEL GAS SCRUBBER
SCHEDULE OF OPENINGS
MARK
REQ'D
SIZE
RATING
TYPE
PROJ.
SERVICE
PRESSURE INDICATOR
TEMPERATURE INDICATOR
LEVEL GAUGE
ACCESS
CLEANOUT
OUTLET (RELIEF)
SIPHON DRAIN
OUTLET
INLET

Information Sheet

d. Locate outlet nozzle and other connections

Examples:	OUTLET 30-301-4	-N2
	DRAIN 426-151-2	-N3
	PSV-602-2" FLANGED	-N4
	4" CLEANOUT FLANGED	-N5
	18" MANWAY FLANGED	-M1
	ACCESS TO CLEANOUT	-A
	LG213 - 3/4 THREADED	-C1 A & B
	TI301 - 3/4 THREADED	-C2
	PI509 - 3/4 THREADED	-C3

e. Use the procedure outlined to transfer information about heat exchangers, heaters, vessels, cooling towers, turbines, pumps, and all other components.

6. **Characteristics of datum dimensioning on elevation views**

   a. Datum dimensioning is used on manufacturers' drawings to avoid accumulative dimensioning and lower the risk of manufacturing error.

   b. The datum line is usually located at the lower seam where the head is welded to the shell.

   c. The lower seam line to the base of the vessel is given in one full dimension such as 2′.

   d. Each nozzle or connection has a datum dimension and sometimes an elevation dimension to grade.

   e. Nozzles and couplings are normally revolved so they can be viewed in one elevation to aid in dimensioning.

Note: Reference the graphic in Objective 8 and note how the above items are incorporated into an elevation view.

Information Sheet

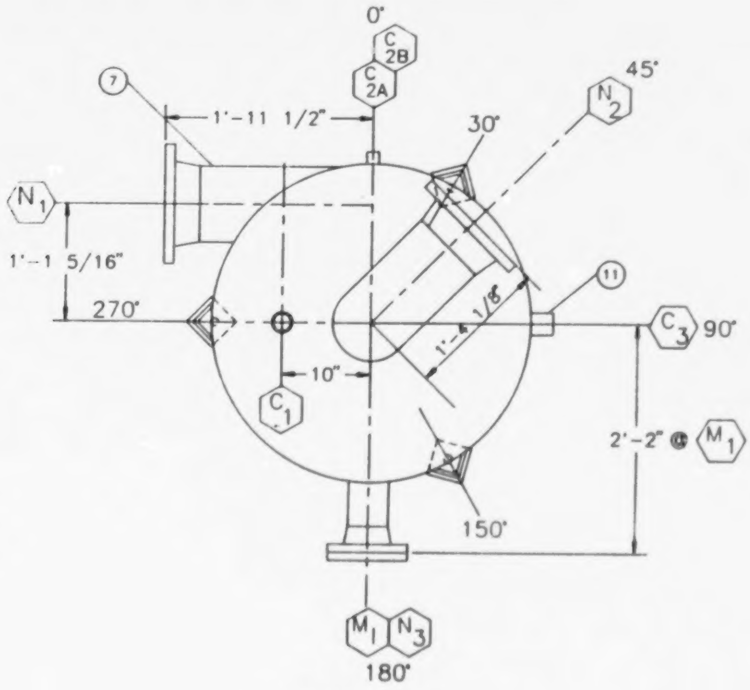
7. Characteristics of dimensioning on orientation views

a. 0° is usually located at the top of an orientation view, and angles are usually CW (clockwise).

> **CAD Alert:** Some shops have begun to locate 0° to the right quadrant and measure angles CCW (counterclockwise).

b. Most connections are located at 0°, 90°, 180°, and 270° to provide for manufacturing ease and speed.

c. Level gauge connections are run vertical (C2A, C2B).


0°
C 2B
C 2A
7
1'-11 1/2"
45°
N 2
30°
N 1
1'-1 5/16"
270°
11
C 3
90°
1'-4 1/8"
10"
C 1
2'-2" ℄ M 1
150°
M 1
N 3
180°

ORIENTATION

Information Sheet

8. Noting nozzle and coupling elevation, orientation, and projection

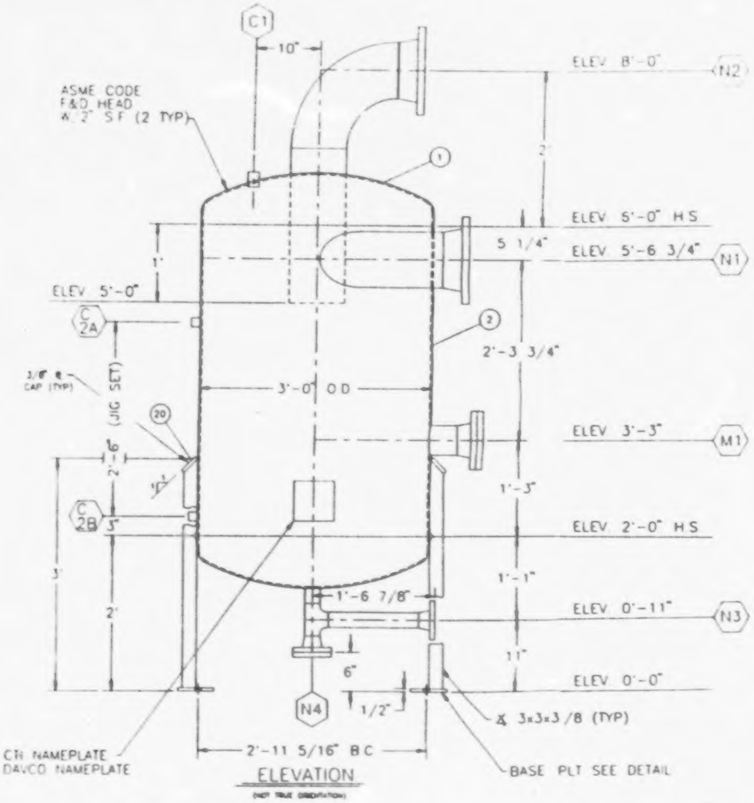
a. Elevation, orientation, and projection of connections on vessels, tanks, and scrubbers are vital information for manufacture and assembly, and must be noted on equipment fabrication drawings.

b. To calculate nozzle elevation, add the nozzle dimension, from the datum, to the base dimension.

c. To dimension nozzle orientation, find the nozzle on the orientation view that you are working with, locate the 0° centerline, move in a CW direction, mark the degrees between the nozzle and 0° centerline.

d. Projection dimensions of connections are usually noted in the schedule of openings.

e. Connections that do not run on a radial from the ℄ are normally dimensioned in the orientation view (N1).


C1
10"
ASME CODE
F&D HEAD
W. 2" S.F. (2 TYP)
ELEV. 8'-0"
N2
2'
1
ELEV. 5'-0" H.S.
5 1/4"
ELEV. 5'-6 3/4"
N1
1'
ELEV. 5'-0"
C 2A
2
2'-3 3/4"
3/8" ⌀ CAP (TYP)
(JIG SET)
3'-0" O.D.
20
2'-6"
ELEV. 3'-3"
M1
1 1/2"
1'-3"
C 2B
3"
ELEV. 2'-0" H.S.
3'
2'
1'-1"
1'-6 7/8"
ELEV. 0'-11"
N3
11"
6"
ELEV. 0'-0"
N4
1/2"
∡ 3x3x3/8 (TYP)
CH NAMEPLATE
DAVCO NAMEPLATE
2'-11 5/16" B.C.
BASE PLT. SEE DETAIL
ELEVATION
(NOT TRUE ORIENTATION)

Information Sheet

9. Types of pumps and their characteristics

a. **Centrifugal** — A type of pump used in 90% of pump installations because it requires little maintenance; these pumps must have a flooded suction, and liquid must not rise after leaving a vessel before entering a pump

b. **Reciprocating** — A pump that draws liquid into a cylinder on an intake stroke and forces out a discharge side with a compression stroke, much like the cylinder on a car; this pump requires dampening because each thrust causes a pulse in the piping, and joint fatigue, leaks, and pulsating flow are drawbacks to this type of pump

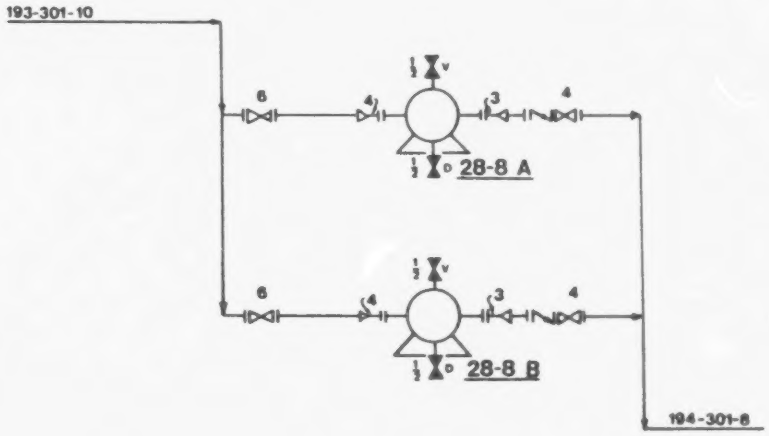
c. **Rotary** — A type of pump used to move heavy material like asphalt, grease, heavy fuel oil, or sludge; the most common pump of this type uses a screw which acts like an augur to push material

10. Selecting and sizing pumps

a. Find the pump equipment symbol and its item number on the mechanical flow diagram because the number will sometimes contain specifications for the pump.

> **CAD Alert:** Engineering firms have begun to attach information to the equipment with attributes that may not be visible on the drawing. The procedure accommodates computer word processing to help accelerate preparation of printed lists and other items.

b. Note the flow direction and determine the entering and discharge line sizes of the pump, and remember that on the suction side where fluid enters, the line is usually larger than the discharger side.



Information Sheet

c. Select the right type of pump for service demands.

Note: Pump types were reviewed in the previous objective.

d. Narrow pump choices by consulting manufacturers' catalogs, and matching the suction and discharge sizes required.

Note: Student Supplement 1 will help you use specifications properly for pump selection.

e. Consult engineer and pump manufacturer to match pump pressure, volume, rate of flow, head pressure, and horsepower of the motor to select the correct pump.

f. Note dimensions of pump and base for drawing platforms and location of piping.

g. Note the selected pump data on the mechanical flow diagram and in equipment legends as required.

11. Tubular heat exchanger

a. In general, a tubular heat exchanger is sized according to size of shells and tube bundles as designated by numbers describing the shell and tube bundle diameters and tube length.

b. Nominal diameter is the inside diameter of the shell in inches, rounded off to the nearest integer.

c. For kettle reboilers, the nominal diameter is the port diameter followed by the shell diameter, each rounded off to the nearest integer.

d. A tubular heat exchanger is identified by letters which indicate its front end stationary head type, its shell type, and its rear end head type.

Information Sheet

e. The letters ABCDN identify front end head types, the letters EFGHJKX identify shell types, and the letters LMNPSTUV identify rear end head types.

Example: An AES tubular head exchanger has a stationary front end head with channel and removable cover, a one pass shell, and a rear end floating head with a backing device.

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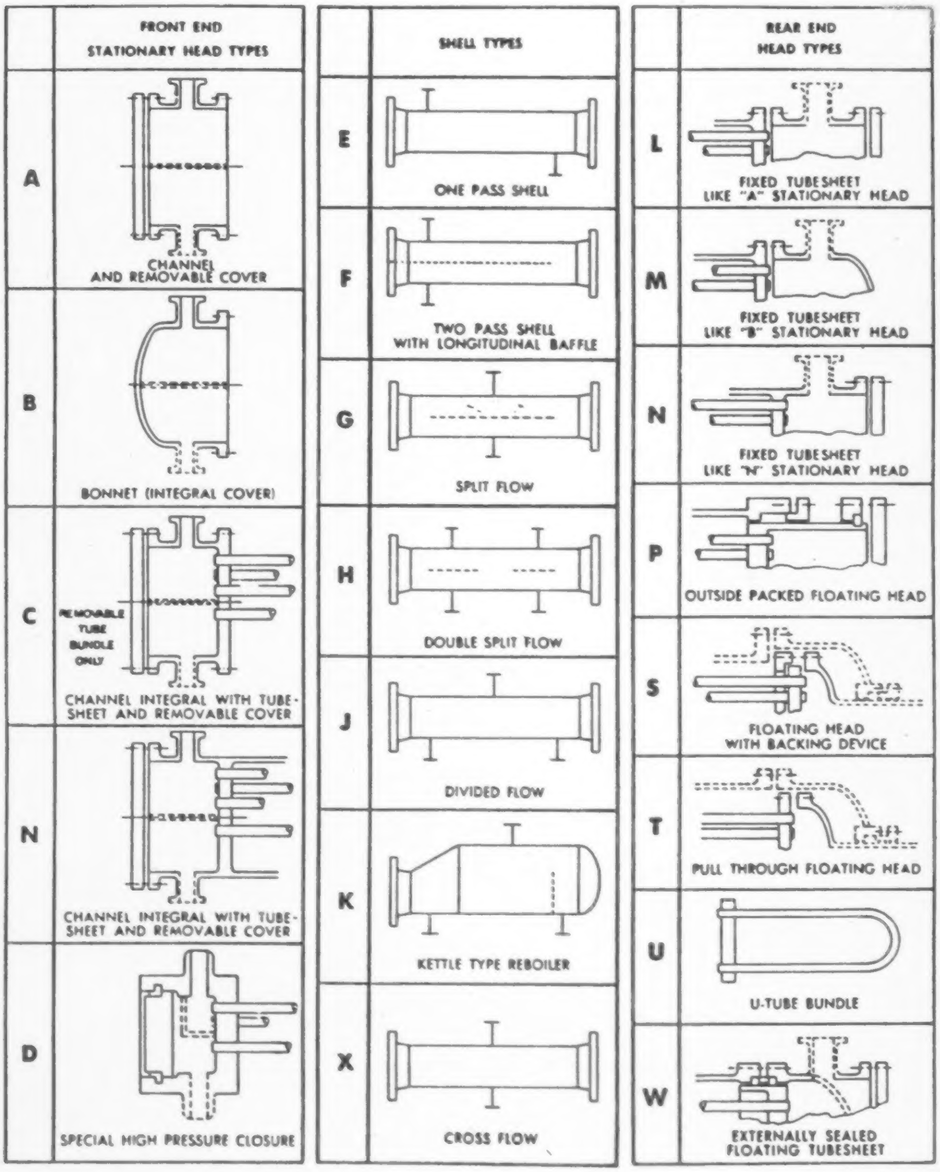

FRONT END STATIONARY HEAD TYPES
A
CHANNEL AND REMOVABLE COVER
B
BONNET (INTEGRAL COVER)
C
REMOVABLE TUBE BUNDLE ONLY
CHANNEL INTEGRAL WITH TUBESHEET AND REMOVABLE COVER
N
CHANNEL INTEGRAL WITH TUBESHEET AND REMOVABLE COVER
D
SPECIAL HIGH PRESSURE CLOSURE
SHELL TYPES
E
ONE PASS SHELL
F
TWO PASS SHELL WITH LONGITUDINAL BAFFLE
G
SPLIT FLOW
H
DOUBLE SPLIT FLOW
J
DIVIDED FLOW
K
KETTLE TYPE REBOILER
X
CROSS FLOW
REAR END HEAD TYPES
L
FIXED TUBESHEET LIKE "A" STATIONARY HEAD
M
FIXED TUBESHEET LIKE "B" STATIONARY HEAD
N
FIXED TUBESHEET LIKE "N" STATIONARY HEAD
P
OUTSIDE PACKED FLOATING HEAD
S
FLOATING HEAD WITH BACKING DEVICE
T
PULL THROUGH FLOATING HEAD
U
U-TUBE BUNDLE
W
EXTERNALLY SEALED FLOATING TUBESHEET

Information Sheet

e. The description of a heat exchanger should include description, sizing, and type.

Example 1: Split-ring floating head exchanger with removable channel and cover, single pass shell, 23 1/4" inside diameter with tubes 16′ long. SIZE 23-192 TYPE AES.

Example 2: Pull-through floating heat kettle type reboiler having stationary head integral with tubesheet, 23" port diameter and 37" inside shell diameter with tubes 16′ long. SIZE 33-96 TYPE CKT.

f. Special designs may best be described as best suits the manufacturer.

Example 1: A single tube pass, fixed tubesheet exchanger with conical heads may be described as "TYPE BEAM with Conical Heads."

Example 2: A pull-through floating head exchanger with an entegral shell cover may be described as "TYPE AET with Integral Shell Cover."

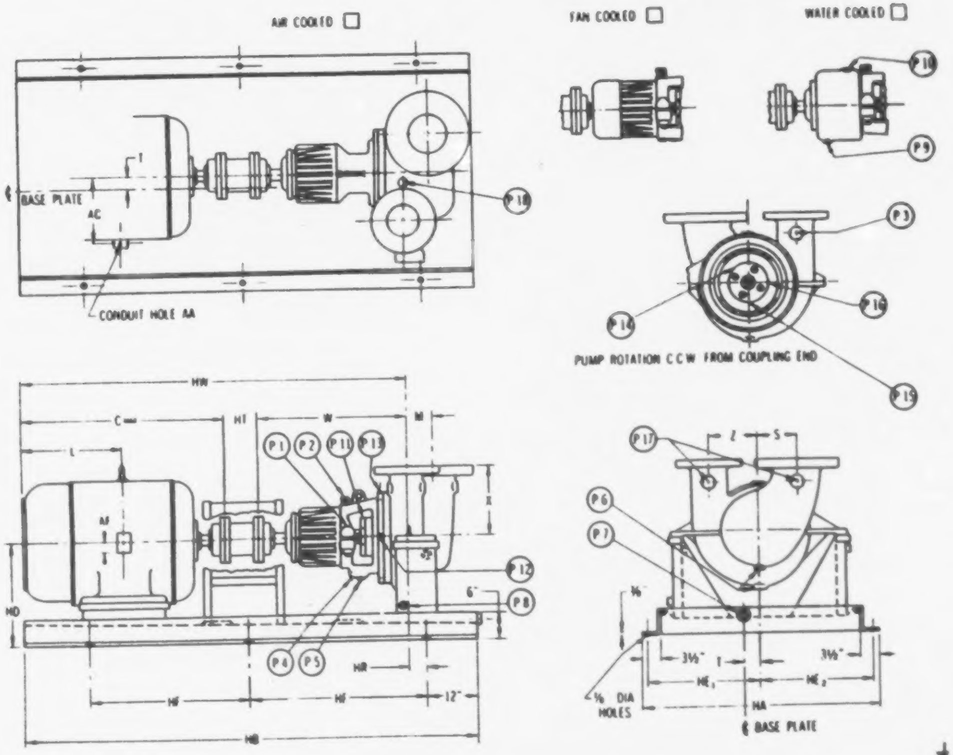
Note: Student Supplement 2 will help you use specifications properly for tubular heat exchanger selection.

Equipment Fabrication Drawings
Unit 7

Student Supplement 1—Pump Data

The materials in this supplement include typical technical references for pumps, motor frame sizes, base plate dimensions, and other data which present the kind of information you will need when selecting and sizing a pump. Reference the materials as needed to help you complete Assignment Sheet 6 in this unit of instruction.

Student Supplement 1


AIR COOLED ☐
FAN COOLED ☐
WATER COOLED ☐
℄ BASE PLATE
T
AC
CONDUIT HOLE AA
P18
P10
P9
P3
P16
P14
P15
PUMP ROTATION C C W FROM COUPLING END
HW
C
HT
W
M
L
X
AF
HD
P1
P2
P11
P13
P12
P8
6"
P4
P5
HR
HF
HF
12"
HB
P17
Z
S
P6
P7
3½"
T
3½"
HE₁
HE₂
⅛ DIA HOLES
HA
℄ BASE PLATE

ITEM	SIZE	DESCRIPTION	YES	NO
P-1	4 OZ	OILER – FAR SIDE	X	
P-2		OIL FILLER CUP	X	
P-3	½ P T	SEAL RECIRCULATION CASE TAP	X	
P-4	½ P T	OIL DRAIN – PLUGGED	X	
P-5	¾ P T	DRAIN	X	
P-6	¾ P T	CASE DRAIN – PLUGGED		
P-7	1½ P T	BASE PLATE DRAIN	X	
P-8	½ P T	PED. COOL. WATER IN & OUT		
P-9	½ P T	INLET BRG. WATER JACKET		
P-10	½ P T	OUTLET BRG. WATER JACKET		
P-11	¼ P T	PACKING GLAND QUENCH		
P-12	½ P T	CAGE RING CONN. IN & OUT ON HORIZ ℄		[illegible]
P-13	SEE NOTE 4	STUFF. BOX WATER JACKET CLOSURE		
P-14	½ P T	SEAL VENT OR QUENCH INLET		
P-15	½ P T	SEAL QUENCH DRAIN		
P-16	½ P T	SEAL INJECTION		
P-17	¾ P T	GAGE CONNECTION		
P-18	¾ P T	VENT CONNECTION		

NOTES:

1. PUMPS ARE SELF VENTING
2. SUCT & DISCH FLGS #300 A S A 1/16 R F
3. THREE 4 DIA GROUT HOLES (MIN) ½ DIA VENT HOLES - 4 CORNERS OF BASE
4. ½ P T IN & OUT ON VERT ℄ ALWAYS SUPPLIED WITH OR WITHOUT WATER JACKET CLOSURE
5. BOSSES PROVIDED FOR ADDITION OF TAPS WHEN REQUIRED
6. BI STD COUPLING GUARD MEETS CALIF SAFETY REQUIREMENTS

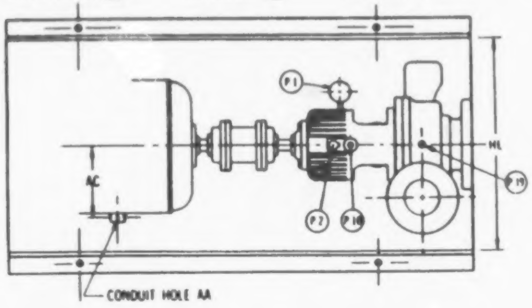
BASEPLATE DIMENSIONS					
BASE NO	HA	HB	HE₁	HE₂	HF
S-7	53	103	27 3/4	21 3/4	39 1/2

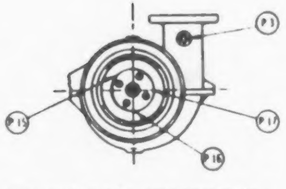
PUMP SIZE				MOTOR FRAME SIZE							326TS			364TS			365TS			↓ 405TS			444TS			445TS			447TS			
										C	29 5/8			30 15/16			31 15/16			35 11/16			38 7/8			40 7/8			47 1/4			
Line No.	Discharge	Suction	Impeller	M	S	W	X	Z	HT	HR	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	T
→ 17	8	10	16	6	5	28 11/16	16	12 1/8	7	7 1/8	27	65 5/16	S-7	27	66 5/8	S-7	27	67 5/8	S-7	27	71 3/8	S-7	27	74 9/16	S-7	27	76 9/16	S-7	27	82 15/16	S-7	3
19	10	12	18	7	5	28 13/16	20	14 1/4	7	5 1/4	27	65 7/16	S-7	27	66 3/4	S-7	27	67 3/4	S-7	27	71 1/2	S-7	27	74 11/16	S-7	27	76 11/16	S-7	27	83 3/16	S-7	3

Courtesy BWIP International

Student Supplement 1

WATER COOLED ☐ FAN COOLED ☐ AIR COOLED ☐





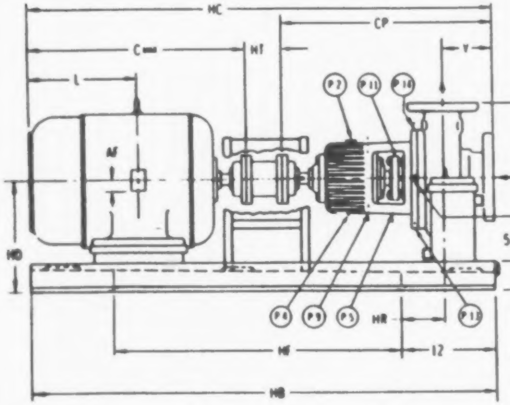
PUMP ROTATION C C W FROM COUPLING END

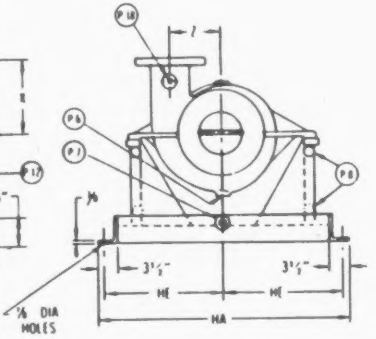
ITEM	SIZE	DESCRIPTION	YES	NO	PLUGGED
P 1	4 OZ	OILER	X		
P 2	⅛	OIL FILLER CUP	X		
P 3	½ P T	SEAL RECIRCULATION CASE TAP	X		
P 4	½ P T	OIL DRAIN	X		X
P 5	⅛ P T	BRACKET DRAIN	X		
P 6	⅜ P T	CASE DRAIN	X		X
P 7	1½ P T	BASE PLATE DRAIN	X		
P 8	½ P T	PED COOL WATER IN & OUT			
P 9	½ P T	INLET BRG WATER JACKET			
P 10	½ P T	OUTLET BRG WATER JACKET			
P 11	⅛ P T	PACKING GLAND QUENCH			
P 12	½ P T	CAGE RING CONN IN & OUT ON HORIZ ℄		Note 5	
P 13	½ P T	INLET STUFF BOX WATER JACKET			
P 14	½ P T	OUTLET STUFF BOX WATER JACKET			
P 15	½ P T	SEAL VENT OR QUENCH INLET			
P 16	½ P T	SEAL QUENCH DRAIN			
P 17	½ P T	SEAL INJECTION			
P 18	⅛ P T	GAGE CONNECTION			
P 19	⅛ P T	VENT CONNECTION			

NOTES:

1 PUMPS ARE SELF VENTING
2 SUCT & DISCH FLGS 300 LB 1/16 R F PER ANSI B 16 5
3 THREE 4 DIA GROUT HOLES (MIN) 1 ⅛ DIA VENT HOLES AS REQUIRED FOR FULL GROUTING
4 ½ P T IN & OUT ON VERT ℄ ALWAYS SUPPLIED WITH OR WITHOUT WATER JACKET CLOSURE FOR ITEM P 9 10 13 14
5 BOSSES PROVIDED FOR ADDITION OF TAPS WHEN REQUIRED
6 BI STD COUPLING GUARD MEETS CALIF SAFETY REQUIREMENTS & OSHA
7 ALL CASE TAPS ON 1 x 1½ x 7⅛ WILL BE ½ P T

TWO REQ'D





BASEPLATE DIMENSIONS					
BASE NO	HA	HB	HE	HF	HL
1A B	28	51	12¼	27	21
2A	28	59	12¼	35	21
3A B C	32	60	14¼	36	25

ITEM NUMBER 28 - 6 A/B
COOLING WATER SUPPLY PUMPS

PUMP SIZE				MOTOR FRAME SIZE							182T			184T			213T			215T			254T			256T		
										C	14 3/16			15 3/16			18 5/16			19 5/16			22 11/16			24 5/16		
Line No	Dis-charge	Suc-tion	Im-peller	Y		CP	X	Z	HT	HR	HD	HC	Base No	HD	HC	Base No	HD	HC	Base No	HD	HC	Base No	HD	HC	Base No	HD	HC	Base No
1	1	1½	7½	4		23 11/16	8	4	4½	4¾	14½	42 11/16	1A	14½	43 11/16	1A	14½	46½	1B	14½	47½	1B						
2	1½	2	8½	4½		24 5/16	8½	5	4½	4½	14½	43 5/16	1A	14½	44 5/16	1A	14½	46½	1B	14½	48½	1B	14½	51½	2A	14½	53½	2A
3	2	3	8½	5½		24½	8½	5	4¾	4½	14½	44	1A	14½	45	1A	14½	47 5/16	1B	14½	48 11/16	1B	14½	52 5/16	2A	14½	53 11/16	2A
4	3	4	8½	6		25 11/16	9	5½	4½	2				17½	45 11/16	3A	17½	48½	3B	17½	49¾	3B	17½	52½	3C	17½	54½	3C

Courtesy BWIP International

BEST COPY AVAILABLE

Equipment Fabrication Drawings
Unit 7

Student Supplement 2—Heat Exchanger Components and Other Data

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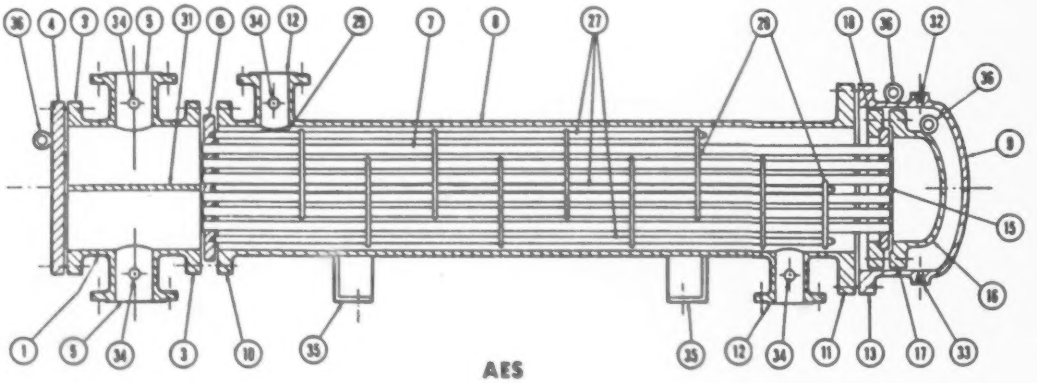
For the purpose of establishing standard terminology, Figure N-2 illustrates various types of heat exchangers. Typical parts and connections, only for the purpose of illustration, are numbered for identification in Table N-2.

Table N-2

1. Stationary Head—Channel
2. Stationary Head—Bonnet
3. Stationary Head Flange—Channel or Bonnet
4. Channel Cover
5. Stationary Head Nozzle
6. Stationary Tubesheet
7. Tubes
8. Shell
9. Shell Cover
10. Shell Flange—Stationary Head End
11. Shell Flange—Rear Head End
12. Shell Nozzle
13. Shell Cover Flange
14. Expansion Joint
15. Floating Tubesheet
16. Floating Head Cover
17. Floating Head Flange
18. Floating Head Backing Device
19. Split Shear Ring
20. Slip-on Backing Flange
21. Floating Head Cover—External
22. Floating Tubesheet Skirt
23. Packing Box
24. Packing
25. Packing Gland
26. Lantern Ring
27. Tierods and Spacers
28. Transverse Baffles or Support Plates
29. Impingement Plate
30. Longitudinal Baffle
31. Pass Partition
32. Vent Connection
33. Drain Connection
34. Instrument Connection
35. Support Saddle
36. Lifting Lug
37. Support Bracket
38. Weir
39. Liquid Level Connection



AES

Student Supplement 2

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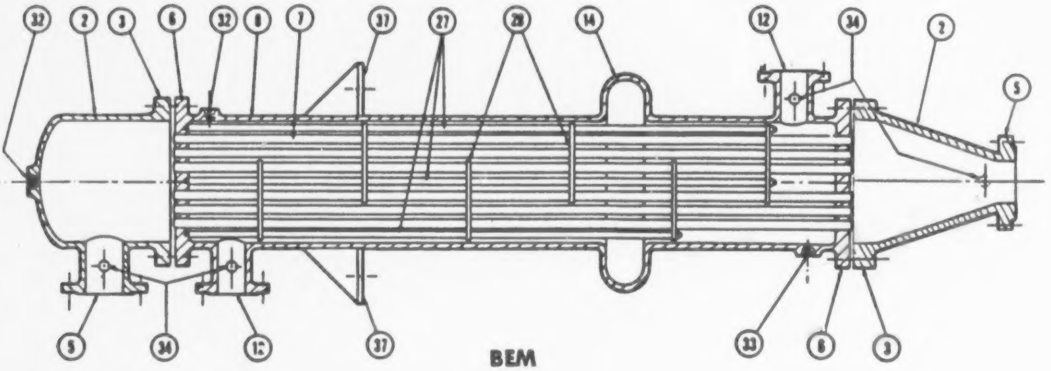
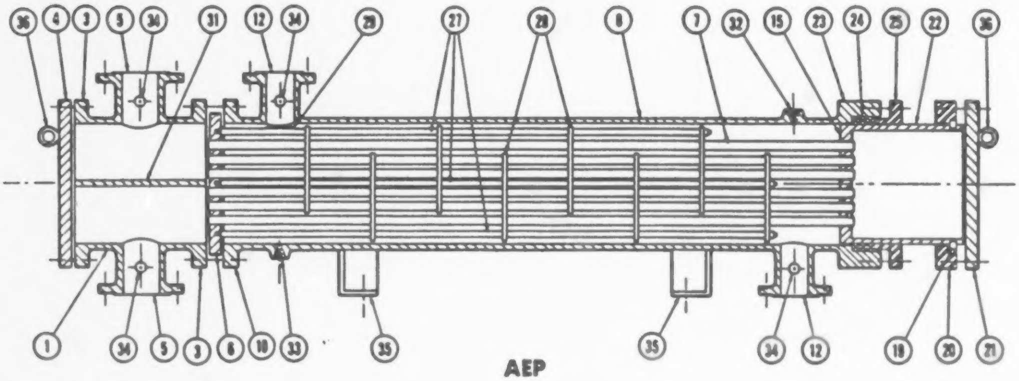
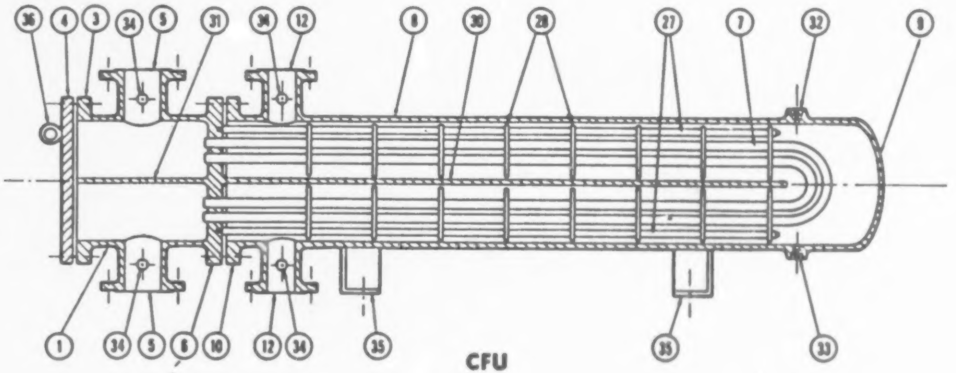

32
2
3
6
32
8
7
37
27
28
14
12
34
2
5
5
34
12
37
33
6
3

BEM


36
4
3
5
34
31
12
34
29
27
28
8
7
32
15
23
24
25
22
36
1
34
5
3
6
10
33
35
35
34
12
18
20
21

AEP


36
4
3
34
5
31
34
12
8
30
28
27
7
32
9
1
34
5
6
10
12
34
35
35
33

CFU

Student Supplement 2

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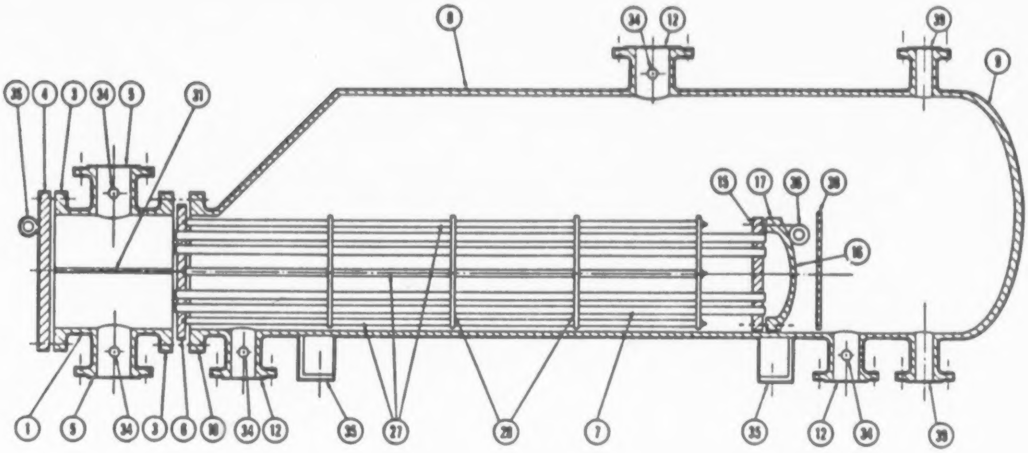
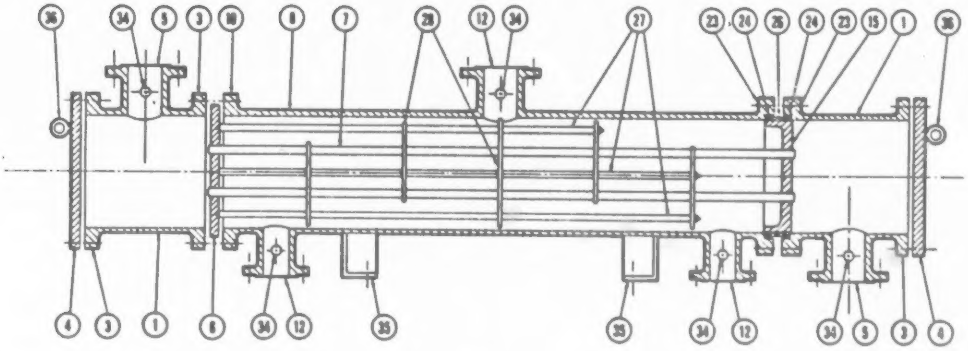

8
34
12
39
9
36
4
3
34
5
31
15
17
36
38
16
1
5
34
3
6
10
34
12
35
27
28
7
35
12
34
39

AKT


36
34
5
3
10
8
7
28
12
34
27
23
24
25
24
23
15
1
36
4
3
1
6
34
12
35
35
34
12
34
5
3
4

AJW

Equipment Fabrication Drawings
Unit 7

Student Supplement 3—BOM and Schedule of Openings Form

Extra forms for a BOM and a Schedule of Openings are included here for use with local materials that may be supplied by your instructor. The forms may also be used for making notes or listing references as you finish the assignment sheets.

Student Supplement 3

BILL OF MATERIAL

ITEM No.	DESCRIPTION	MATERIAL	

Student Supplement 3

SCHEDULE OF OPENINGS

					MATERIAL LIST NO									REPAD		NECK			PROJ.		WELD DETAIL DWG		WELD SIZE			
MARK	No REQ'D	SIZE	RATING	TYPE	FL	NE	CO	BO	GA	PA	TH	CP	FIT	O.D. x THK	MAT'L	SCH	WALL	MAT'L	O.S.	L.S.	WELD DETAIL		a	b	c	SERVICE
																										LEVEL SWITCH
																										LEVEL GA
																										LEVEL GA
																										VENT
																										CLEAN OUT
																										OUTLET
																										HANDHOLE
																										DRAIN
																										INLET

SCHEDULE OF OPENINGS

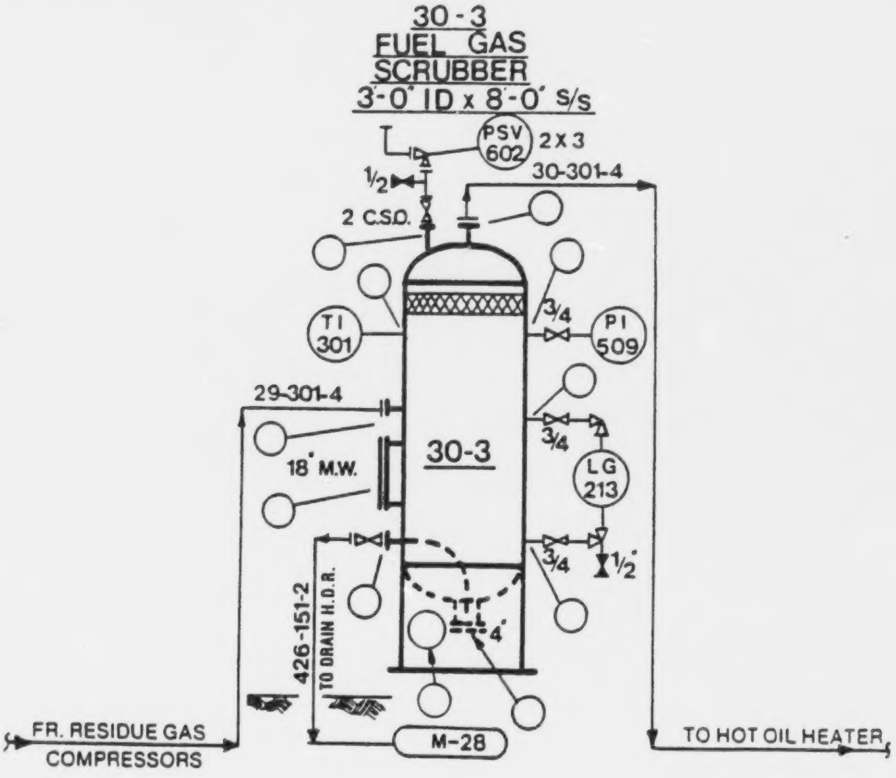
Equipment and Fabrication Drawings
Unit 7

Assignment Sheet 1—Locate Nozzle Mark Numbers on a Mechanical Flow Diagram

Name ________________________ Overall Rating ____________

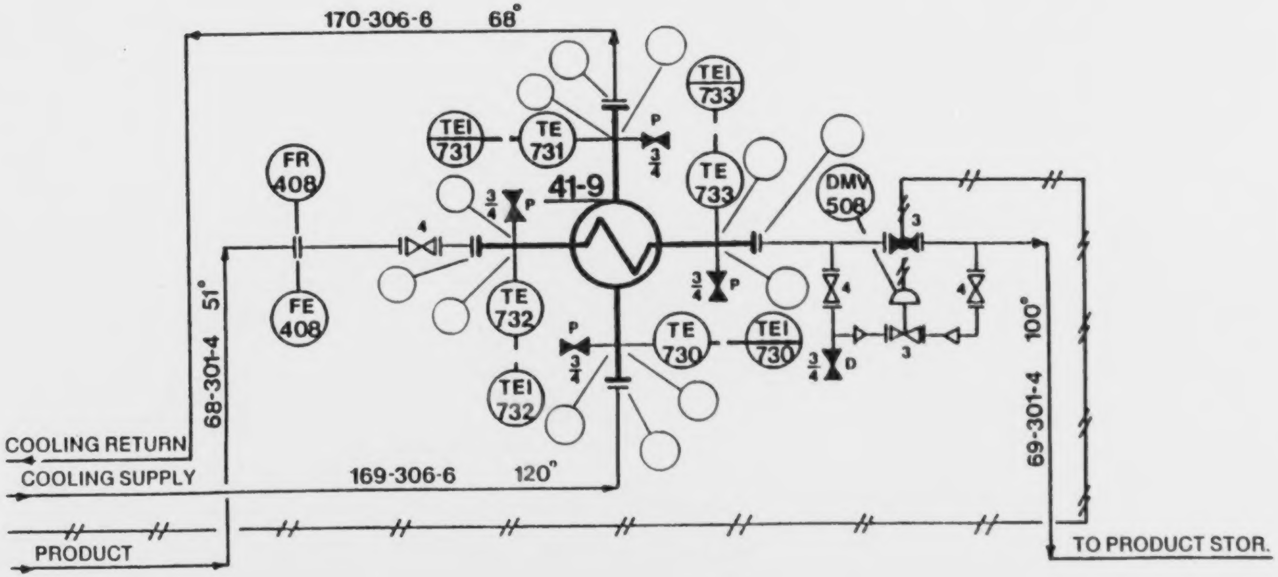
Evaluation criteria	Rating
Nozzle mark numbers correctly identified	______
Nozzle mark number entered in correct balloons	______
Lettering and general neatness	______

Directions: Label the connections of the 30-3 FUEL GAS SCRUBBER and the 41-9 PRODUCT HEAT EXCHANGER as they would appear on an equipment manufacturers equipment fabrication drawing. Use N, C, A, or M to mark connections properly, and place marks and numbers in the correct balloon.


30 - 3
FUEL GAS
SCRUBBER
3'-0" ID x 8'-0" S/S
PSV 602
2 X 3
1/2
30-301-4
2 C.S.O.
3/4
TI 301
PI 509
29-301-4
30-3
18" M.W.
3/4
LG 213
3/4
1/2"
426-151-2
TO DRAIN H.D.R.
4"
FR. RESIDUE GAS COMPRESSORS
M-28
TO HOT OIL HEATER

Assignment Sheet 1

41-9
PRODUCT
HEAT EXCHANGER


170-306-6
68°
TEI 733
TEI 731
TE 731
TE 733
P
3/4
FR 408
41-9
DMV 508
3
4
3/4
P
FE 408
TE 732
3/4
P
4
4
51°
68-301-4
P
3/4
TE 730
TEI 730
3
3/4
D
100°
TEI 732
69-301-4
COOLING RETURN
COOLING SUPPLY
169-306-6
120°
PRODUCT
TO PRODUCT STOR.

Equipment Fabrication Drawings
Unit 7

Assignment Sheet 2—Calculate Nozzle Elevation Dimensions From Given Mark Numbers on a Manufacturer's Drawing

Name ______________________ Overall Rating __________

Evaluation criteria	**Rating**
Number of problems attempted	_____
Number of correct problems	_____

Directions: Refer to the mechanical flow diagram that accompanies this assignment to answer the following problems:

Problems:

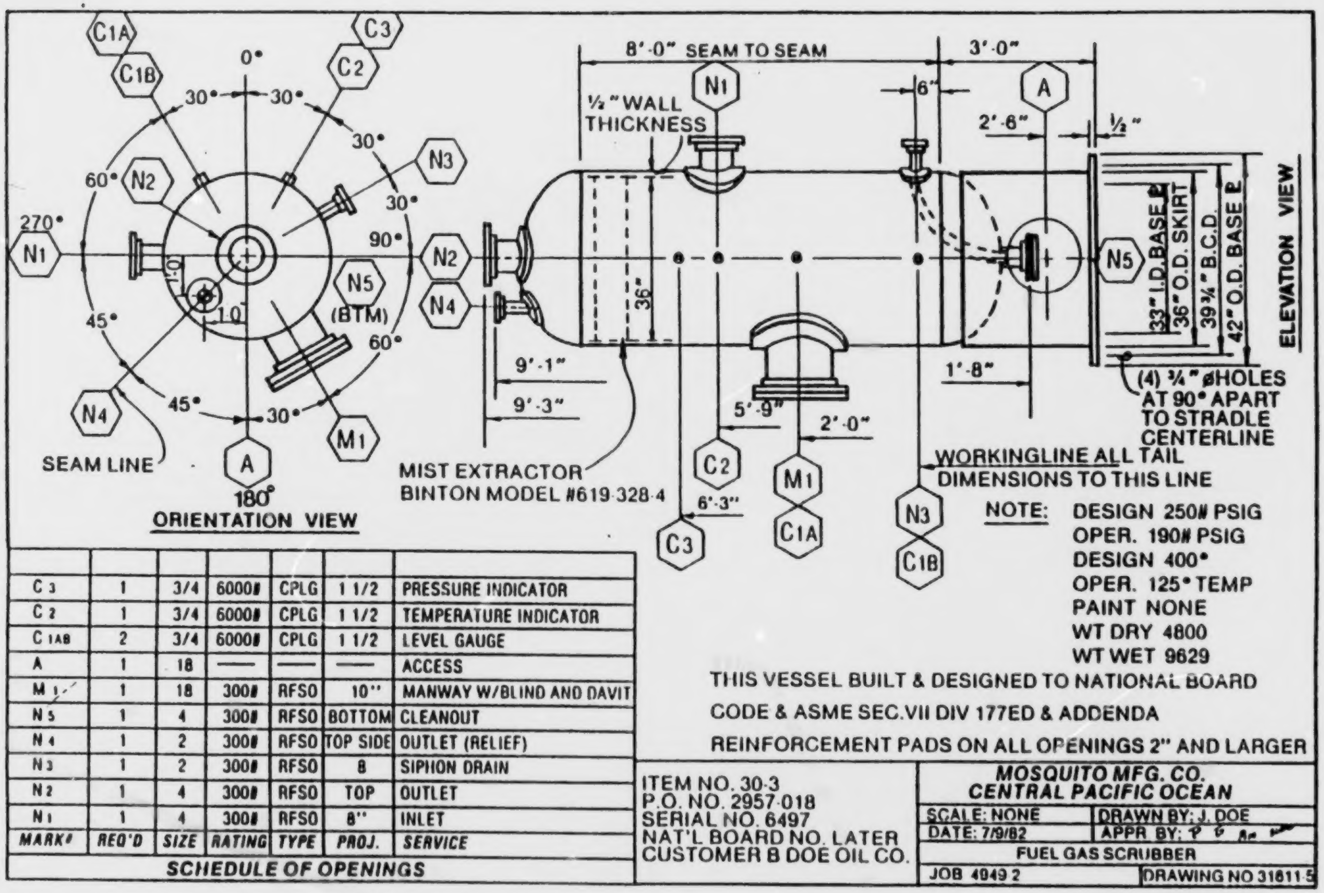
a. What is the dimension from the bottom of the vessel to the centerline of line no. 29-301-4? ______________________

b. What is the dimension from the bottom of the vessel to the centerline of line no. 426-151-2? ______________________

c. What is the dimension from the bottom of the vessel to the face of flange for line no. 30-301-4? ______________________

d. What is the dimension from the bottom of the vessel to the face of flange for mark no. N4? ______________________

Assignment Sheet 2


C1A
C1B
0°
C3
C2
30°
30°
30°
N3
60°
N2
30°
270°
N1
90°
N2
N5
(BTM)
N4
1.0
1.0
45°
60°
45°
30°
N4
M1
SEAM LINE
A
180°
ORIENTATION VIEW
8'-0" SEAM TO SEAM
3'-0"
N1
6"
A
½" WALL THICKNESS
2'-6"
½"
36"
N5
33" I.D. BASE ℄
36" O.D. SKIRT
39¾" B.C.D.
42" O.D. BASE ℄
ELEVATION VIEW
9'-1"
9'-3"
1'-8"
5'-9"
2'-0"
6'-3"
(4) ¾" ⌀HOLES AT 90° APART TO STRADLE CENTERLINE
C2
M1
C1A
C3
N3
C1B
WORKINGLINE ALL TAIL DIMENSIONS TO THIS LINE
MIST EXTRACTOR
BINTON MODEL #619-328-4

NOTE: DESIGN 250# PSIG
OPER. 190# PSIG
DESIGN 400°
OPER. 125° TEMP
PAINT NONE
WT DRY 4800
WT WET 9629

THIS VESSEL BUILT & DESIGNED TO NATIONAL BOARD CODE & ASME SEC.VII DIV 177ED & ADDENDA

REINFORCEMENT PADS ON ALL OPENINGS 2" AND LARGER

C_3	1	3/4	6000#	CPLG	1 1/2	PRESSURE INDICATOR
C_2	1	3/4	6000#	CPLG	1 1/2	TEMPERATURE INDICATOR
C_{1AB}	2	3/4	6000#	CPLG	1 1/2	LEVEL GAUGE
A	1	18	——	——	——	ACCESS
M_1	1	18	300#	RFSO	10"	MANWAY W/BLIND AND DAVIT
N_5	1	4	300#	RFSO	BOTTOM	CLEANOUT
N_4	1	2	300#	RFSO	TOP SIDE	OUTLET (RELIEF)
N_3	1	2	300#	RFSO	8	SIPHON DRAIN
N_2	1	4	300#	RFSO	TOP	OUTLET
N_1	1	4	300#	RFSO	8"	INLET
MARK#	*REQ'D*	*SIZE*	*RATING*	*TYPE*	*PROJ.*	*SERVICE*

SCHEDULE OF OPENINGS

ITEM NO. 30-3
P.O. NO. 2957-018
SERIAL NO. 6497
NAT'L BOARD NO. LATER
CUSTOMER B DOE OIL CO.

MOSQUITO MFG. CO.
CENTRAL PACIFIC OCEAN

SCALE: NONE	DRAWN BY: J. DOE
DATE: 7/9/82	APPR BY: P G
FUEL GAS SCRUBBER	
JOB 4949 2	DRAWING NO 31611-5

Equipment Fabrication Drawings
Unit 7

Assignment Sheet 3—Calculate Nozzle Orientation in Degrees From Given Mark Numbers on a Manufacturer's Drawing

Name ______________________ Overall Rating ______________

Evaluation criteria	**Rating**
Number of problems attempted	______
Number of correct problems	______

Directions: Refer to VIEW C-C that accompanies this assignment to solve the following problems:

Problems:

a. What is the angle for connection C4? ______________________

b. What is the angle for connection C8? ______________________

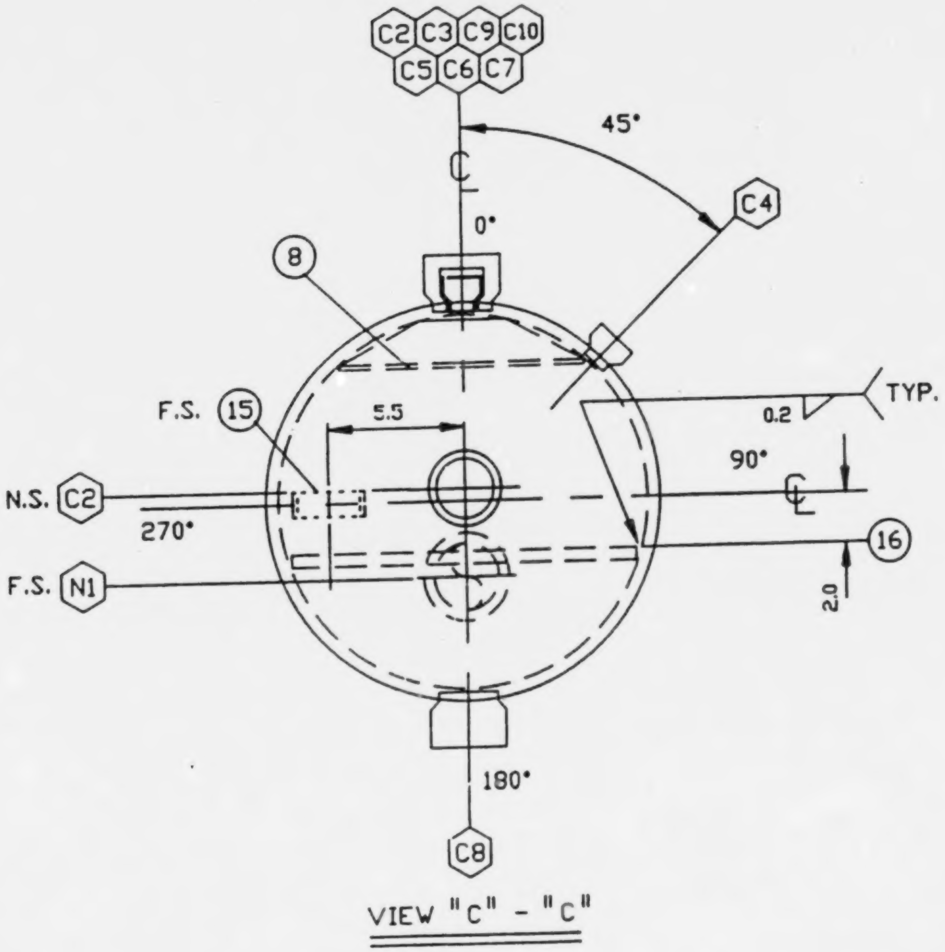
c. What is the angle from north for the level gauge? ______________________

d. Is the inlet nozzle on the near side or far side? ______________________

e. Is the C2 connection on the near side or far side? ______________________

f. What is the angle of connection C9? ______________________

Assignment Sheet 3


C2
C3
C9
C10
C5
C6
C7
45°
C4
0°
8
F.S.
15
5.5
TYP.
0.2
90°
N.S.
C2
270°
16
F.S.
N1
2.0
180°
C8
VIEW "C" - "C"

Equipment Fabrication Drawings
Unit 7

Assignment Sheet 4—Locate Information on a Manufacturer's Drawing

Name ______________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Number of problems attempted	_____
Number of correct problems	_____

Directions: Refer to the manufacturer's drawing of a heat exchanger that accompanies this assignment to answer the following problems.

Problems:

a. What is the design pressure of this piece of equipment? ____________

b. What is the testing pressure? ____________

c. What is the design temperature? ____________

d. Where is the exchanger to be installed? ____________

e. What is the weight of the vessel when empty? ____________

f. What is the weight of the vessel when full of water? ____________

g. What is the name of the company that is going to build this piece of equipment? ____________

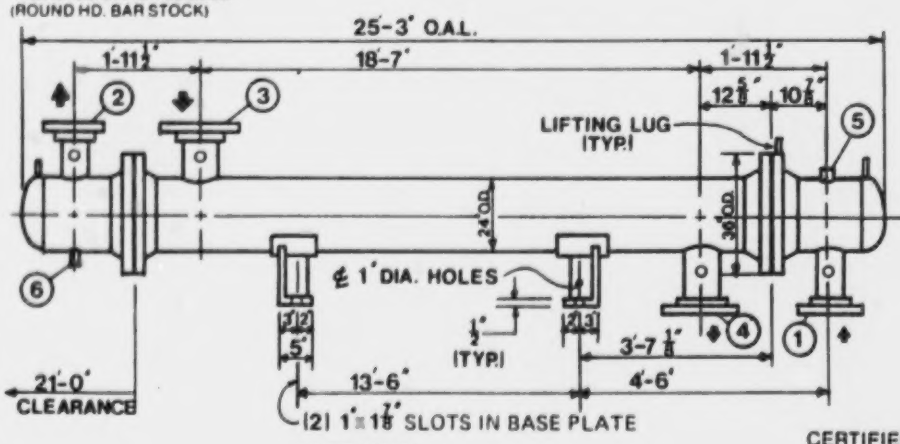
Assignment Sheet 4

Manufacturer's Drawing — Exchanger

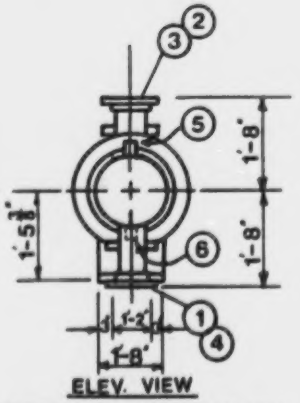
MK	NOZZLE	SIZE - SERIES
1	TUBE OUTLET	4"-300# RFSO
2	TUBE OUTLET	4"-300# RFSO
3	SHELL INLET	6"-300# RFSO
4	SHELL OUTLET	6"-300# RFSO
5	VENT	3/4 "-6000# CPLG
6	DRAIN	3/4 "-6000# CPLG

DESCRIPTION	SHELL	TUBE	CUSTOMER:MAVCC ENG. CO.
DESIGN PRESS (PSI)	100	150	DESTINATION :JONES PET.CO. LEE PLANT
TEST PRESS (PSI)	150	225	HALLET, ARKANSAS
DESIGN TEMP (°F)	150	150	PURCHASE ORDER #6247-019
CORROSION ALLOW (in.)	1/8"	1/8"	CUST.ITEM #A-6238-421-15-6(6247-41-9) ←
NUMBER PASSES	ONE	ONE	SERVICE: PRODUCT HEAT EXCHANGER
RADIOGRAPH	NO	SPOT	WEIGHT: DRY 9,750# WET 14,125#
HEAT TREAT	YES	YES	NUMBER UNITS REQ'D: ONE

EACH NOZ. EQUIP'D WITH (2)
¾"-6000# CPLG'S AS SHOWN
ALL CPLG'S ARE PLUGGED
(ROUND HD. BAR STOCK)


25'-3" O.A.L.
1'-11½"
18'-7"
1'-11½"
12 5/8"
10 7/8"
②
③
⑤
⑥
LIFTING LUG (TYP.)
24" O.D.
30" O.D.
℄ 1" DIA. HOLES
½" (TYP.)
3 | 2
2 | 3
5"
④
①
3'-7 1/8"
21'-0" CLEARANCE
13'-6"
4'-6"
(2) 1" x 1 7/8" SLOTS IN BASE PLATE

SIDE VIEW


②
③
⑤
⑥
①
④
1'-8"
1'-8"
1'-5 3/8"
1"
1'-2"
1"
1'-8"

ELEV. VIEW

CERTIFIED CORRECT FOR FABRICATION
BY Bob Johnson DATE 2/9/95

NOTES:

1. ALL BOLTS HOLES TO STR. ℄'S
2. PAINT;SANDBLAST & PAINT WITH (1)COAT OF DUPONT PRIMER # 825-8031 (3) MILS. (MIN.) D.F.T.

REV	DATE	DESCRIPTION
△3		
△2		
△1	3/6/95	GEN COST REV

REVISIONS

W.W. ENTERPRISES, INC.
Tulsa, Okla.

DATE 2/3/95	BY DV	DWG NO.1048-2-1
SCALE NONE	TYPE BEM	APPR P △1

Equipment Fabrication Drawings
Unit 7

Assignment Sheet 5—Complete a Schedule of Openings Chart From a Mechanical Flow Diagram

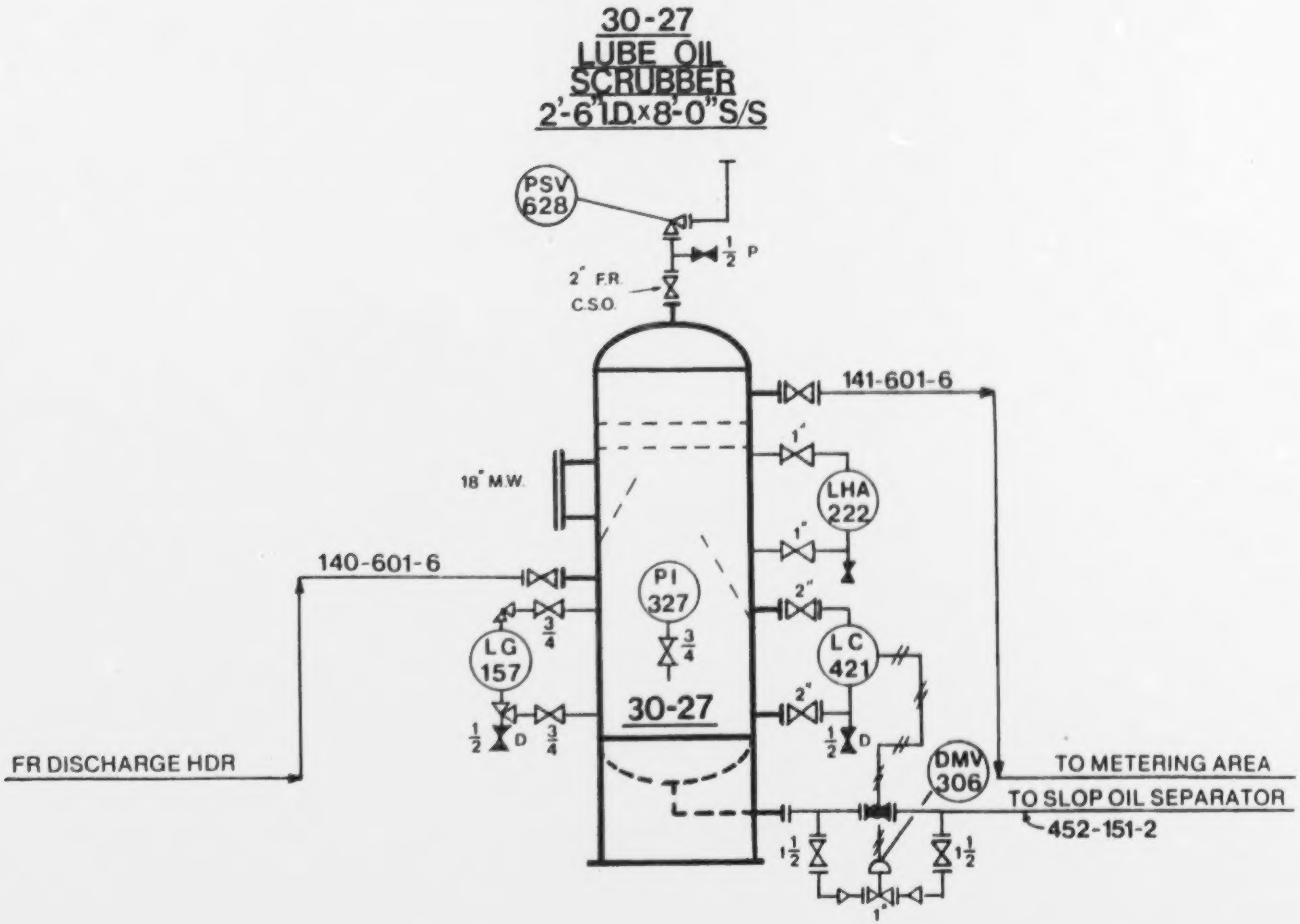
Name ______________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Number of openings entered in chart	______
All items required properly entered	______
Lettering and general neatness	______

Directions: Use the mechanical flow diagram with this assignment sheet to complete the following chart of a schedule of openings to include the access opening in the skirt. For reference, all nozzles have 8″ projections from 2″ to 12″ sizes, 10″ projection from 14″ to larger sizes, and couplings have a 1 1/2″ projection and a 6000# rating.

MARK#	**REQ'D**	**SIZE**	**RATING**	**TYPE**	**PROJ.**	**SERVICE**
SCHEDULE OF OPENINGS						

Assignment Sheet 5


30-27
LUBE OIL
SCRUBBER
2'-6"I.D.x8'-0"S/S
PSV
628
1/2 P
2" F.R.
C.S.O.
141-601-6
1"
LHA
222
1"
18" M.W.
140-601-6
PI
327
3/4
3/4
LG
157
1/2 D
3/4
2"
LC
421
2"
1/2 D
30-27
FR DISCHARGE HDR
DMV
306
TO METERING AREA
TO SLOP OIL SEPARATOR
452-151-2
1 1/2
1 1/2
1"

Equipment Fabrication Drawings
Unit 7

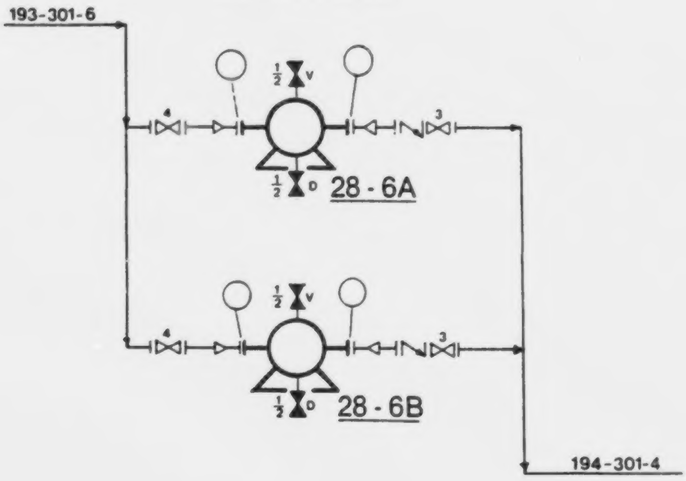
Assignment Sheet 6—Use a Pump Specification Sheet to Find Nozzle Sizes on a Flow Diagram

Name ______________________ Overall Rating __________

Evaluation criteria	Rating
Number of nozzle sizes identified	______
Number of nozzle sizes properly entered in balloons	______
Lettering and general neatness	______

Directions: Use the pump specification materials in Student Supplement 1 to find the correct nozzle sizes. Place the nozzle sizes in the correct balloons on the diagram.

28-6 A/B
Cooling Water
Supply Pumps



List all pump numbers that have top inlet-side discharge with their correct nozzle sizes, A through F.

____

____

Piping Design Fundamentals
Unit 8

Objective Sheet

Unit Objective

After completing this unit, the student should be able to construct ladder and circular platform outline drawings and lay out and pipe up a fractionation tower and pumps. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to piping design fundamentals with their correct definitions.
2. Match main control station components with their functions.
3. Select true statements about sizing and dimensioning a control station.
4. Complete statements about piping for pumps.
5. Complete statements about guidelines for piping heat exchangers.
6. Solve problems about guidelines for piping fired heaters.
7. Select true statements about guidelines for piping gas compressors.
8. Complete statements about guidelines for piping columns, accumulators, and storage vessels.
9. Select true statements about piping liquid level instruments.
10. Complete statements about guidelines for drawing ladders and platforms.
11. Construct ladder and circular platform outline drawings. (Assignment Sheet 1)
12. Lay out and pipe up a fractionation tower and pumps. (Assignment Sheet 2)

Piping Design Fundamentals
Unit 8

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.

2. Review Teaching Suggestions section that follows. Plan for classroom activities.

3. Plan enrichment of exceptional students as well as accommodation of special needs students.

4. Make transparencies from transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Typical Control Stations (Objective 1)
   TM 2—Typical Control Stations (Continued) (Objective 1)
   TM 3—Pump Section and Discharge Piping (Objective 3)
   TM 4—Pump Section Arrangements (Objectives 3 and 4)
   TM 5—Exchanger Piping (Objective 5)
   TM 6—Fired Heater Piping (Objective 6)
   TM 7—Fired Heater Piping (Continued) (Objective 6)
   TM 8—Compressor Piping (Objective 7)
   TM 9—Compressor Piping (Continued) (Objective 7)
   TM 10—Column and Tower Piping (Objective 9)
   TM 11—Typical Level Instrument Connection (Objective 10)
   TM 12—Typical Platform Elevation (Objective 11)
   TM 13—Platforms and Ladders (Objective 10)
   TM 14—Platforms and Ladders (Continued) (Objective 10)
   TM 15—Platforms and Ladders (Plan Views) (Objective 10)

5. Develop teaching plan. Adjust for different learning styles.

6. Make copies of Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.

8. Discuss unit and specific objectives.

9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.

Suggested Activities

10. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment sheets.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Use the transparency masters as previously suggested, but also use the TMs to emphasize the importance of the relationships in placing components—where check valves go and where they don't go, and the placement of such components as pressure reducer valves. Skill areas: **Learning skills, learning to learn.**

2. Review the assignment sheets in detail. Provide students with sample drawings from local industries, if you have drawings available. This is a good place to get students to their CAD workstations and point out the importance of storing and then being able to retrieve time-consuming projects. Skill areas: **Foundation skills, listening.**

Resources Used in Developing This Unit

1. Davis, Ronald and Donald White. *Pipe Drafting*. Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

2. Hartman, William and Fred Williams. *Pipe Drafting*. New York: Gregg Division/McGraw-Hill Book Co., 1981.

3. Weaver, Rip. *Process Piping Drafting*, 3rd. ed. Houston, TX: Gulf Publishing Company, 1990.

Suggested Activities

Suggested Supplemental Resources

To help first-time CAD students learn the ins and outs of DOS and managing the file systems needed for CAD, order *The CAD Survival Kit*. It is the first of MAVCC's CAD series, and available from the Mid-America Vocational Curriculum Consortium. For information, call toll free: 1-800-654-3988.

Piping Design Fundamentals
Unit 8

Answers to Assignment Sheets

Assignment Sheets 1 and 2

Evaluate according to criteria written in the respective assignment sheets.

Piping Design Fundamentals
Unit 8

Answers to Written Test

1. a. 11
   b. 3
   c. 15
   d. 5
   e. 9
   f. 14
   g. 12
   h. 7
   i. 1
   j. 4
   k. 8
   l. 13
   m. 10
   n. 2
   o. 6

2. a. 2
   b. 5
   c. 1
   d. 4
   e. 7
   f. 3
   g. 6

3. b, c, d

4. a. Rise, an overhead
   b. Offsets, on the discharge side
   c. More
   d. Bypass lines

5. a. Locations
   b. Does not interfere
   c. Flange
   d. Up, down

6. a. (3)
   b. (1)

7. b, d, e, f

8. a. Directly onto the nozzle if possible
   b. Flanged steel
   c. Vents
   d. Outlet
   e. 15′-0″

9. b, d, e, f

10. a. 15′-0″
    b. 2′-6″
    c. 8′-0″
    d. Elevation of grating

Piping Design Fundamentals
Unit 8

Written Test

Name ______________________ Date ______________ Score ______

1. Match the terms on the right with the correct definitions.

______a. Supports piping from the lower side of an elbow

______b. Any valve that does not regulate or throttle flow

______c. A common line used for manifolding multiple instruments to one pair of connections on a vessel

______d. A pipe loop which provides partial or full flow of material around a piece of equipment or valve station

______e. A small diameter pipe connected from inlet to outlet side of a valve with its own small valve to allow line contents to pass to the other side of a disk or gate to equalize pressure for ease of operation

______f. A compressor used to increase pressure by centrifugal force

______g. A device used to eliminate pulsation in a line

______h. A pipe loop consisting of a control valve, various fittings, and block valves to regulate the flow, pressure, or quantity of material at a predetermined location

1. Dummy leg
2. Strainer
3. Block valve
4. Manifold
5. Bypass pipe
6. Stuffing steam
7. Control station
8. Main line
9. Bypass valve
10. Reciprocating compressor
11. Base ell support
12. Compressor bottle
13. Pipe loop
14. Centrifugal compressor
15. Bridle/manifold

Written Test

_______i. A piece of pipe or rolled steel welded to another piece of pipe to support the weight of a line

_______j. A main line pipe with several connections

_______k. The primary section of a piping system which contains the process fluid or major service

_______l. A straight piece of pipe bent to a radii to receive an angle of 180° to 360°

_______m. A compressor with several pistons in motion; used to increase power

_______n. Perforated flat or conical metal inserted between flanges upstream from pumps to filter out impurities that might damage the equipment or the product

_______o. Steam used to extinguish a fire caused by tube rupture or to purge a heater before lighting

2. Match main control station components with their functions. Place the number beside the component in the blank beside the description of its function.

_______a. Usually an electronically controlled valve used to throttle flow in relation to temperature, pressure, or flow itself

_______b. A valve tied into a control valve to open and close as needed to keep temperature, pressure, or flow from exceeding design standards

_______c. Keeps flow from reversing

_______d. Shuts off flow for service

_______e. Releases air during start up or shut down, and also used for taking samples

1. Check valve
2. Control valve
3. Dummy leg
4. Gate valve
5. Bypass valve
6. Reducers
7. Drain

Written Test

_______f. Supports weight of pipe and liquid so station will not bear weight or shock

_______g. Placed on both sides of a control valve to insure proper measurements

3. Select true statements about guidelines for sizing and dimensioning a control station. Place an "X" beside each true statement.

_______a. Design the control valve larger than the main line, and design the bypass valves with a capacity one size smaller than the control valve.

_______b. Allow maintenance clearance space between the bottom of the control valve and the actual grade or platform, and a minimum 12′ clearance between the top of the actuator and any fixture directly above the diaphragm case.

_______c. Allow a 6″ minimum clearance between a handwheel and vertical lines or flanges, and increase the clearance by a distance equal to the thickness of insulation if insulation is used.

_______d. Dimension the vertical location of all valves and the horizontal location of flanged and welded-end valves.

_______e. Support the control station so that the control valve can be removed and serviced by removing a minimum amount of surrounding pipe.

4. Complete statements about piping for pumps. Circle the material that best completes each of the following statements.

a. Flow should never (**drop**) (**rise**) before entering a pump; always feed a pump from (**an overhead**) (**a lower**) source.

b. When suction side or discharge side piping interferes with pump connections, make (**offsets**) (**design changes**) to allow for connection on (**the discharge side only**) (**either side**).

c. Since pumps require (**less**) (**more**) maintenance than vessels, and motors require periodic replacement, provide sufficient areas for maintenance and access.

d. Install pumps in pairs so one can be used as backup in conjunction with (**bypass lines**) (**the control station**) so flow can continue while a pump is being serviced.

Written Test

5. Complete statements about guidelines for piping heat exchangers. Circle the material that best completes each of the following statements.

   a. Check manufacturer's drawings for shell and tube, inlet and outlet, and sizes and (**locations**) (**weights**).

   b. Design exchanger piping so that it (**minimally interferes**) (**does not interfere**) with bundle or shell removal.

   c. (**Pipe**) (**Flange**) all vessel connections for easy access, maintenance, and replacement.

   d. Design lines so that fluids being heated will flow (**up**) (**down**), and design lines so that fluids being cooled will flow (**down**) (**up**).

6. Solve problems about guidelines for piping fired heaters. Circle the number beside the statement that best solves each of the following problems.

   a. A fellow drafter has looked at manufacturer's specifications for piping a fired heater. Your associate says the specs are standard and there is nothing in particular that they point out. You might remind your friend that:

      (1) Specifications are almost always standard.

      (2) Specifications may list important sources for components.

      (3) Specifications should definitely include proper location of safety shut off equipment because it is critical.

   b. You notice that specifications do not call for any vibration reducing components for the piping on a fired furnace. You should:

      (1) Check with the head drafter or project engineer because heaters do produce vibration and its possible the item has been overlooked.

      (2) Assume that the heater is designed to eliminate vibration.

      (3) Assume that the vibration produced by the heater will not affect piping.

Written Test

7. Select true statements about guidelines for piping gas compressors. Place an "X" beside each true statement.

_______a. Design compressor inlet piping so that it is lower than the compressor inlet.

_______b. Design all compressor piping to prevent pocketing and low spots in the lines where condensate could build up and severely damage compressor equipment.

_______c. Make all inlet and discharge lines as straight as possible with nothing more than 45° turns near the compressor.

_______d. Locate all piping clear of compressor rotor removal area or access doors.

_______e. Place bottles on the inlet side of compressors to reduce line shock.

_______f. Locate support fittings and valves to reduce surge and vibration.

8. Complete statements about guidelines for piping columns, accumulators, and storage vessels. Circle the material that best completes each of the following statements.

a. When valves are connected to vessels, place them (**as close to the vessel as possible**) (**directly onto the nozzle if possible**).

b. Unless otherwise specified, use (**flanged steel**) (**flanged iron**) valves because they are fire proof and less expensive than many other types of valves.

c. Allow for placement of drains and (**sumps**) (**vents**) in all lines.

d. Provide for thermal expansion on (**inlet**) (**outlet**) lines.

e. Design platforms at all access points if a column is over (**15′-0″**) (**8′-0″**) high.

9. Select true statements about piping liquid level instruments. Place an "X" beside each true statement.

_______a. Liquid level instruments control levels in vessels by controlling inlet flow only.

_______b. Liquid level instruments are also used to monitor and record liquid level in vessels.

_______c. In general, liquid level piping uses two welded connections to attach to vessels.

_______d. A common piping application is to have a top-mounted level gauge with a bottom-mounted outlet control.

_______e. Another piping application is to have a side-mounted level gauge with a bottom-mounted inlet.

_______f. Another piping application is to have a side-mounted level gauge with a top-mounted inlet.

10. Complete statements about guidelines for drawing ladders and platforms. Circle the material that best completes each of the following statements.

    a. Design platforms for elevations above (**15′-0″**) (**8′-0″**) to provide maintenance and inspection access for manways, nozzles, peep holes, and control stations.

    b. Design platforms with a minimum (**2′-6″**) (**2′-0″**) walking space.

    c. Provide safety cages for all elevations above (**15′-0″**) (**8′-0″**).

    d. Label platforms in order from the lowest to the highest from (**elevation of grating**) (**elevation of first platform**).

***Permission to duplicate this test is granted.**

Piping Design Fundamentals
Unit 8

Unit Evaluation Form

Student Name ______________________________ Unit Rating __________

Assignment Sheet 1—Construct Ladder and Circular Platform Outline Drawings Rating _____

Comments: ____

____

Assignment Sheet 2—Lay Out and Pipe Up a Fractionation Tower and Pumps Rating _____

Comments: ____

____

Written Test Scores

Pretest _____ Posttest _____ Other _____

Other ____

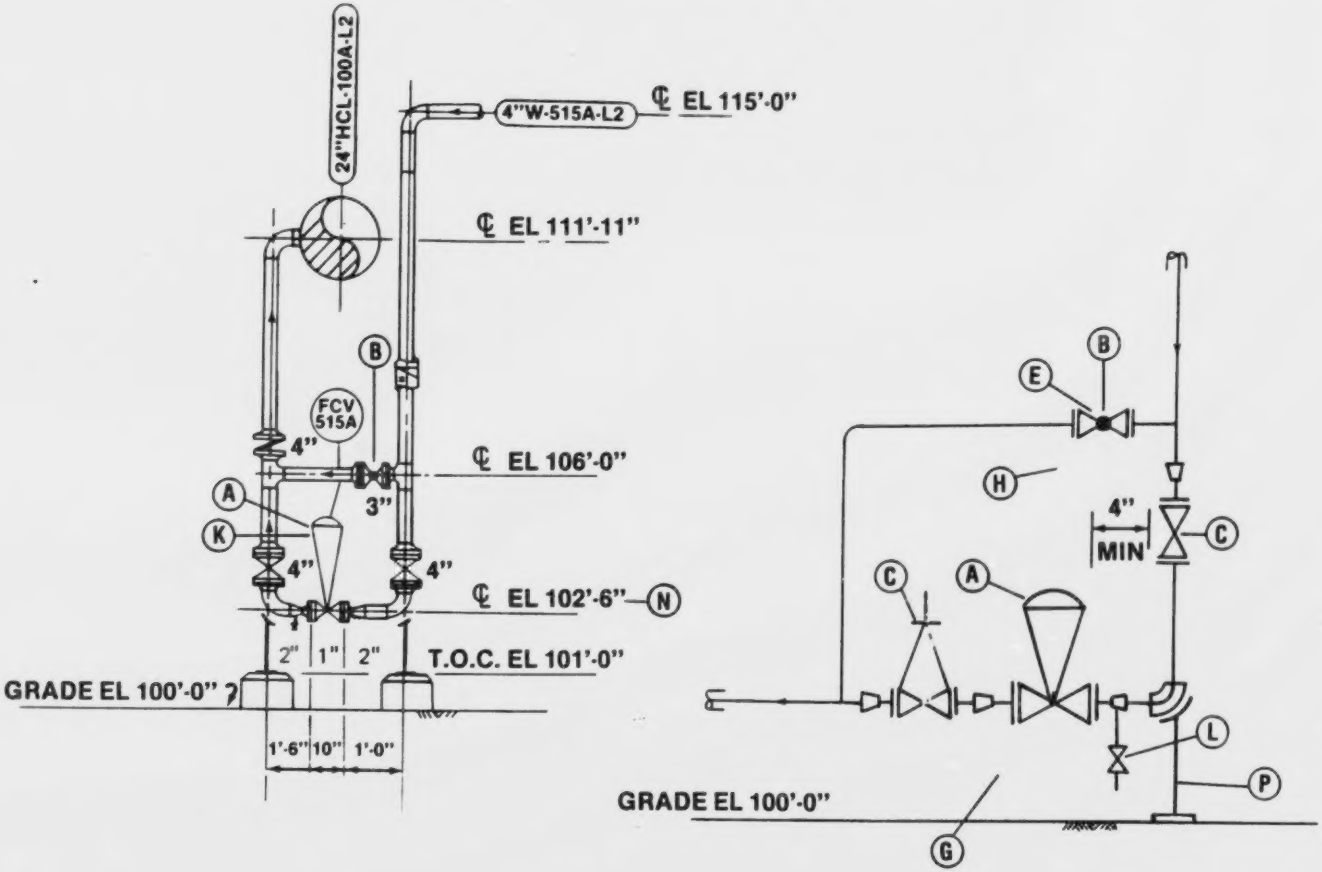
____

Teacher Signature ______________________________ Date __________

Student Signature ______________________________ Date __________

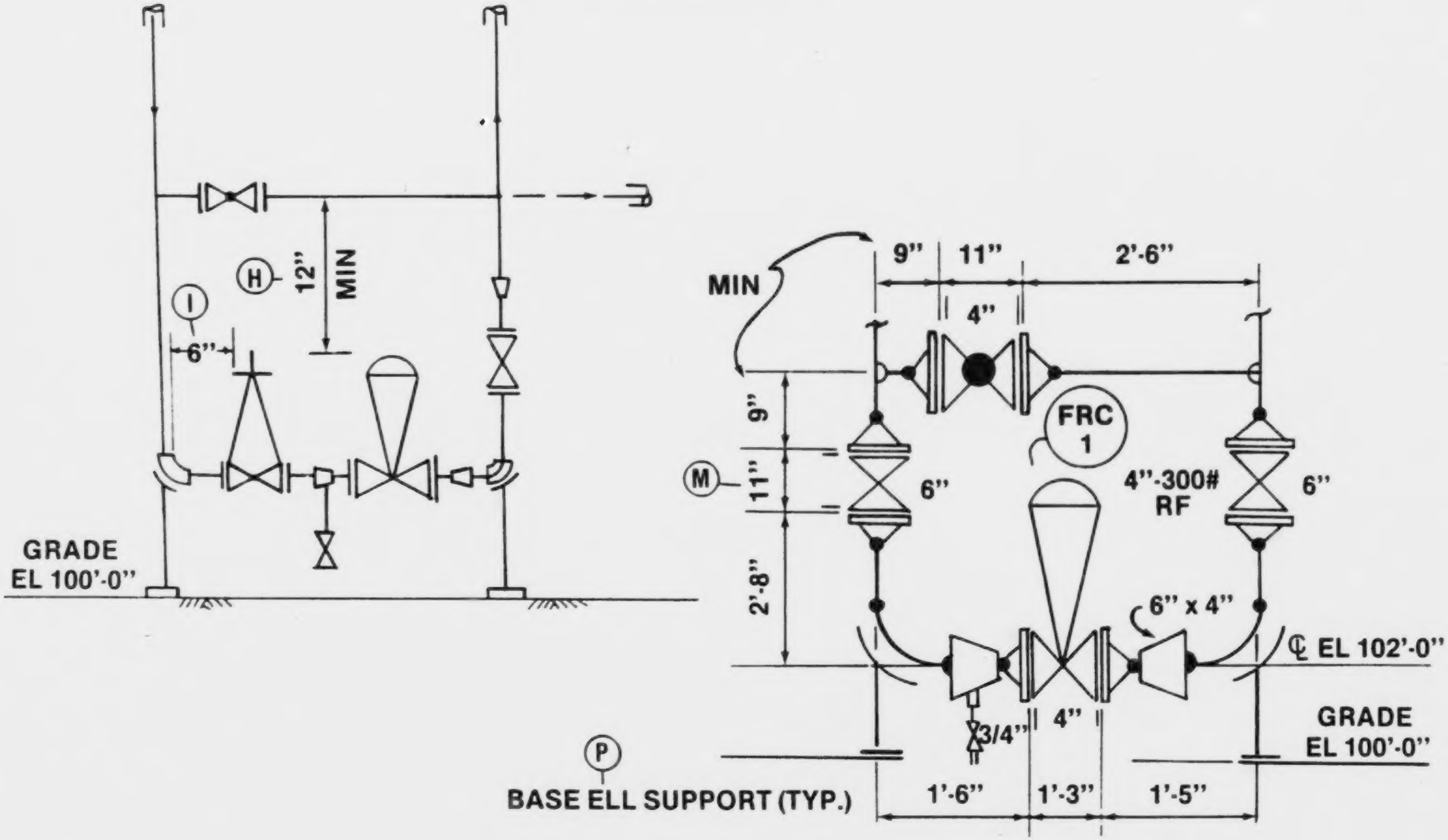
*Permission to duplicate this form is granted.

Typical Control Stations


24"HCL-100A-L2
4"W-515A-L2
℄ EL 115'-0"
℄ EL 111'-11"
B
FCV 515A
4"
℄ EL 106'-0"
A
3"
K
4"
4"
℄ EL 102'-6"
N
2"
1"
2"
T.O.C. EL 101'-0"
GRADE EL 100'-0"
1'-6"
10"
1'-0"
B
E
H
4"
MIN
C
C
A
L
P
GRADE EL 100'-0"
G

Pipe Drafting With CAD, Unit 8
Teacher Page 17

Typical Control Stations
(Continued)



I
6"
H
12"
MIN
GRADE
EL 100'-0"
MIN
9"
11"
2'-6"
4"
9"
FRC
1
M
11"
6"
4"-300#
RF
6"
2'-8"
6" x 4"
℄ EL 102'-0"
3/4"
4"
GRADE
EL 100'-0"
P
BASE ELL SUPPORT (TYP.)
1'-6"
1'-3"
1'-5"

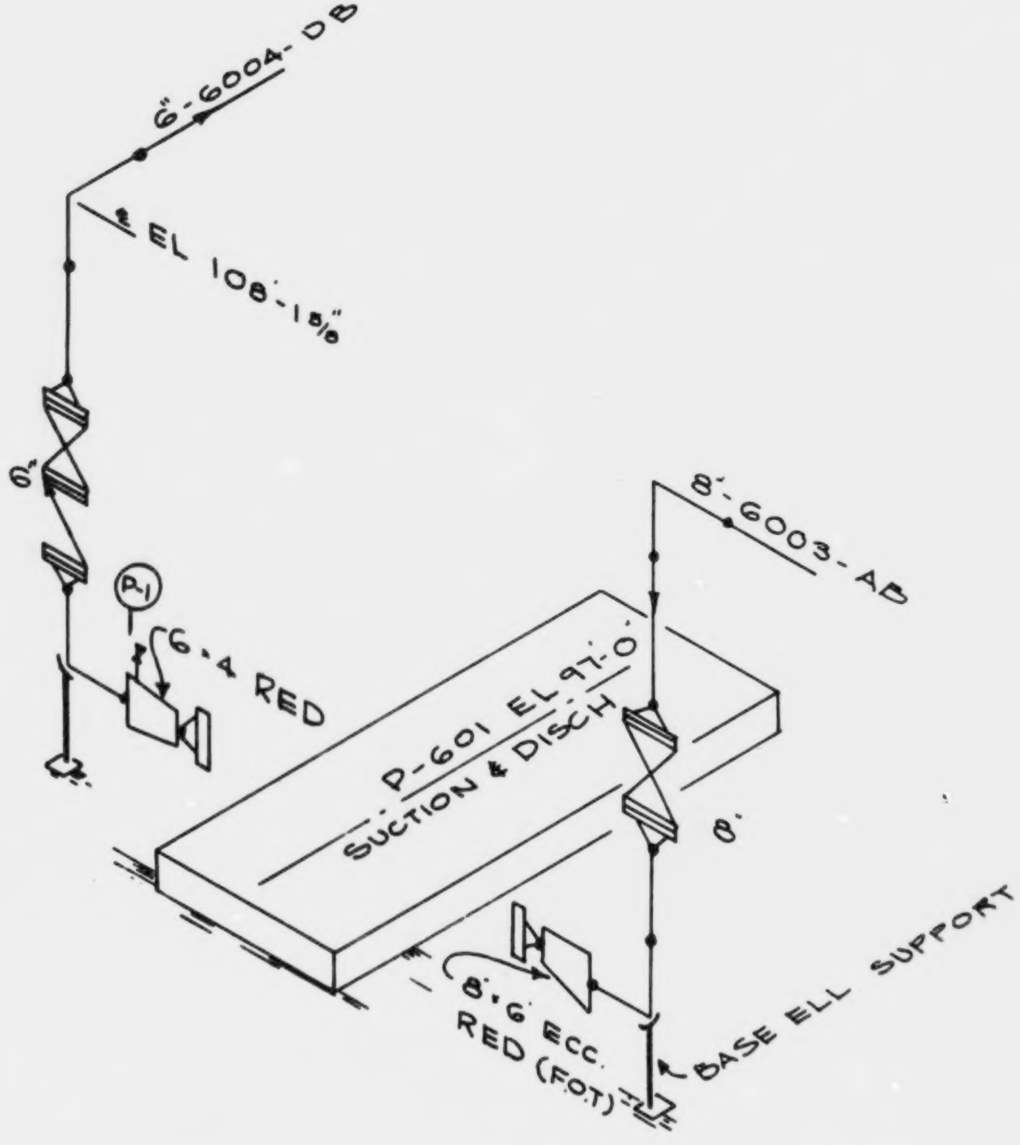
Pipe Drafting With CAD, Unit 8
Teacher Page 19

TM 2

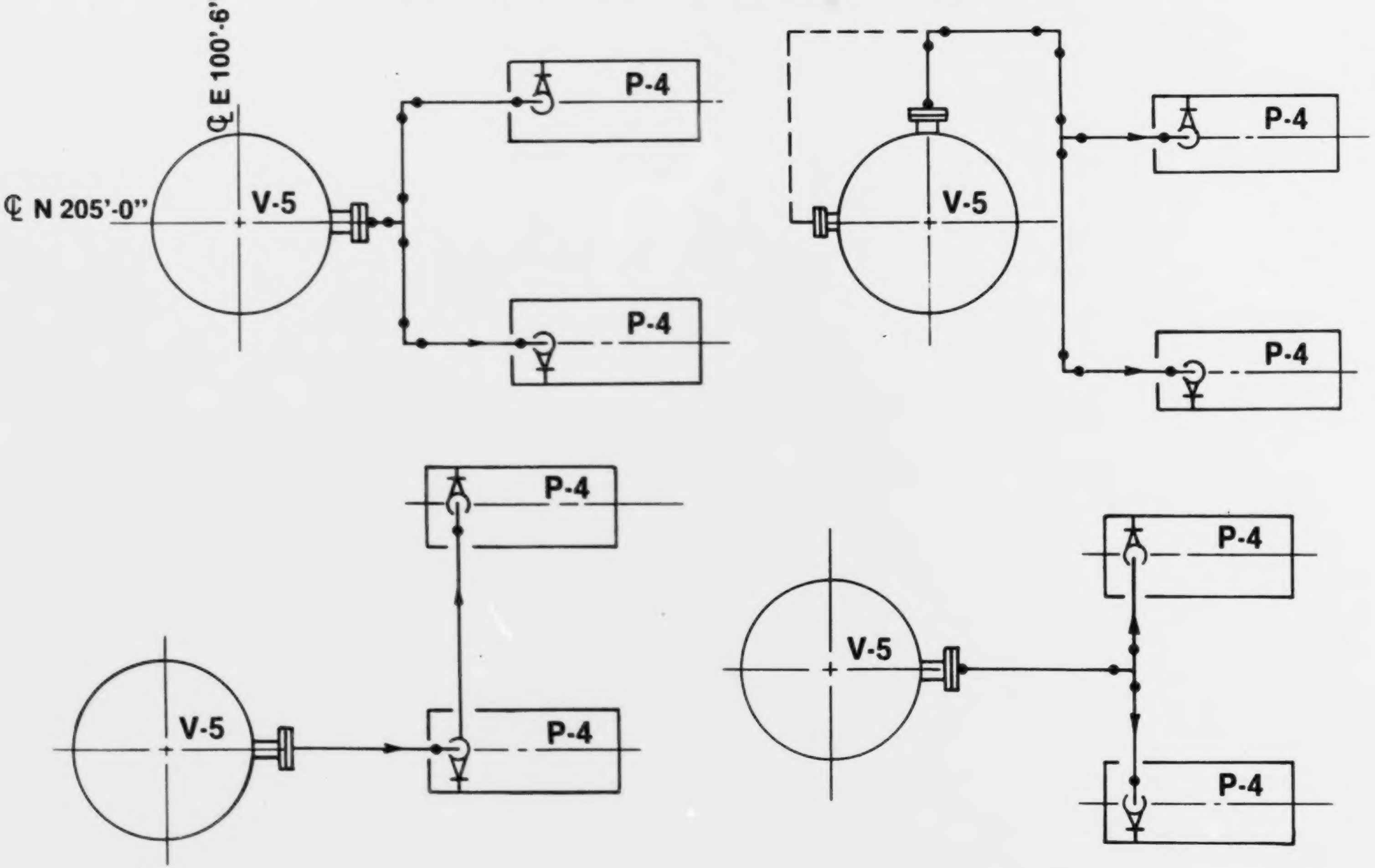
602

603

Pump Suction and Discharge Piping


6"-6004-DB
℄ EL 108'-1 5/8"
6"
P-1
6×4 RED
8"-6003-AB
P-601 EL 97'-0"
SUCTION & DISCH
8"
8×6 ECC.
RED (F.O.T.)
BASE ELL SUPPORT

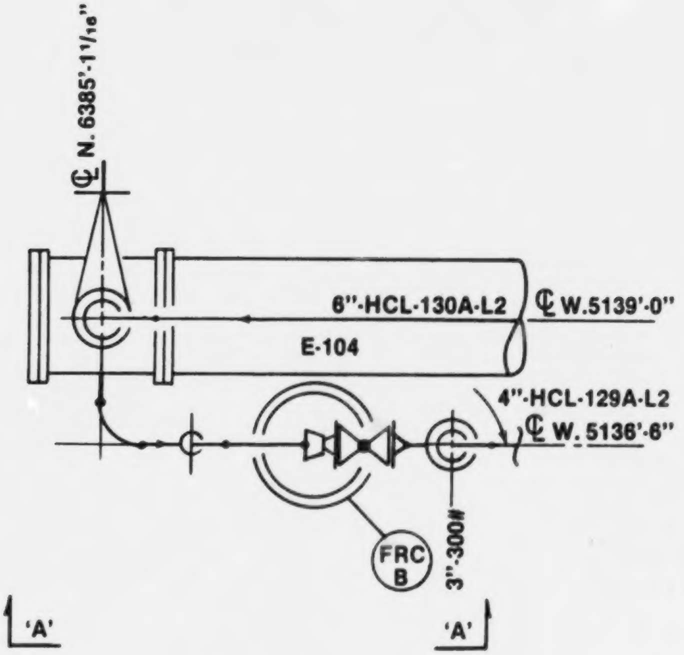
Pump Suction Arrangements


℄ E 100'-6"
℄ N 205'-0"
V-5
P-4
P-4
V-5
P-4
P-4
P-4
P-4
V-5
P-4
V-5
P-4
P-4

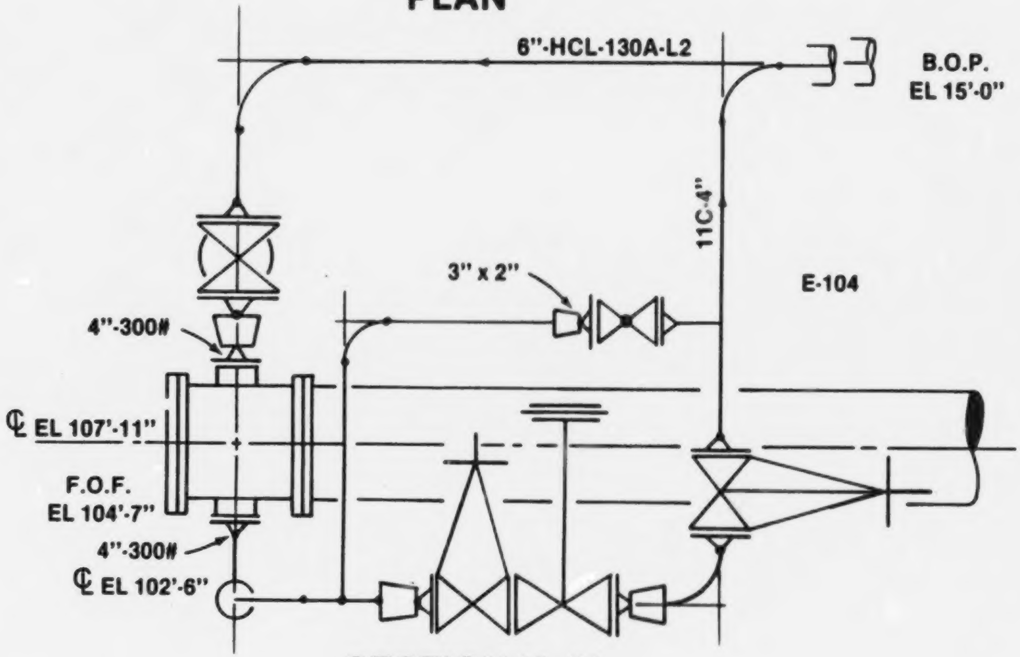
605

606

Exchanger Piping

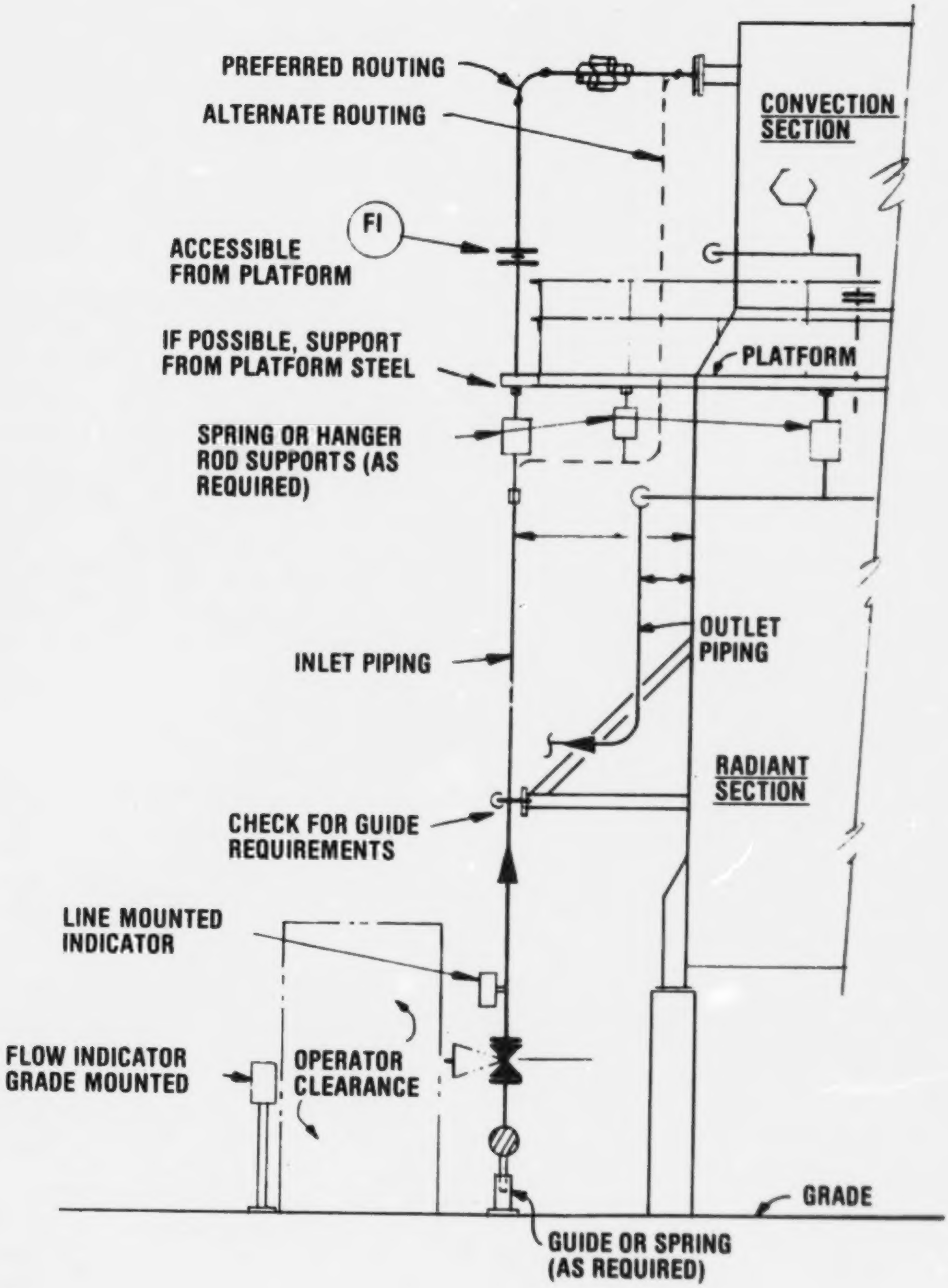

℄ N. 6385'-1 1/16"
6"-HCL-130A-L2
℄ W.5139'-0"
E-104
4"-HCL-129A-L2
℄ W. 5136'-6"
FRC B
3"-300#
'A'
'A'

PLAN


6"-HCL-130A-L2
B.O.P. EL 15'-0"
11C-4"
3" x 2"
E-104
4"-300#
℄ EL 107'-11"
F.O.F. EL 104'-7"
4"-300#
℄ EL 102'-6"

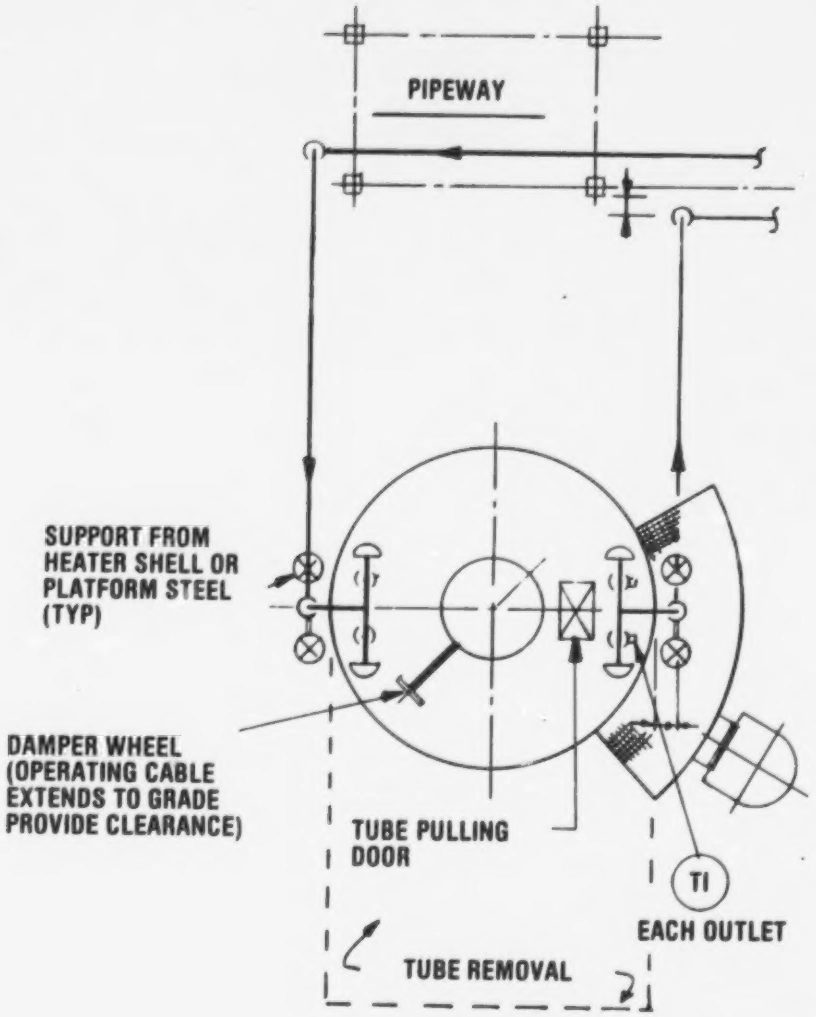
SECTION 'A-A'

Fired Heater Piping


PREFERRED ROUTING
ALTERNATE ROUTING
CONVECTION SECTION
FI
ACCESSIBLE FROM PLATFORM
IF POSSIBLE, SUPPORT FROM PLATFORM STEEL
PLATFORM
SPRING OR HANGER ROD SUPPORTS (AS REQUIRED)
INLET PIPING
OUTLET PIPING
RADIANT SECTION
CHECK FOR GUIDE REQUIREMENTS
LINE MOUNTED INDICATOR
FLOW INDICATOR GRADE MOUNTED
OPERATOR CLEARANCE
GRADE
GUIDE OR SPRING (AS REQUIRED)

Fired Heater Piping

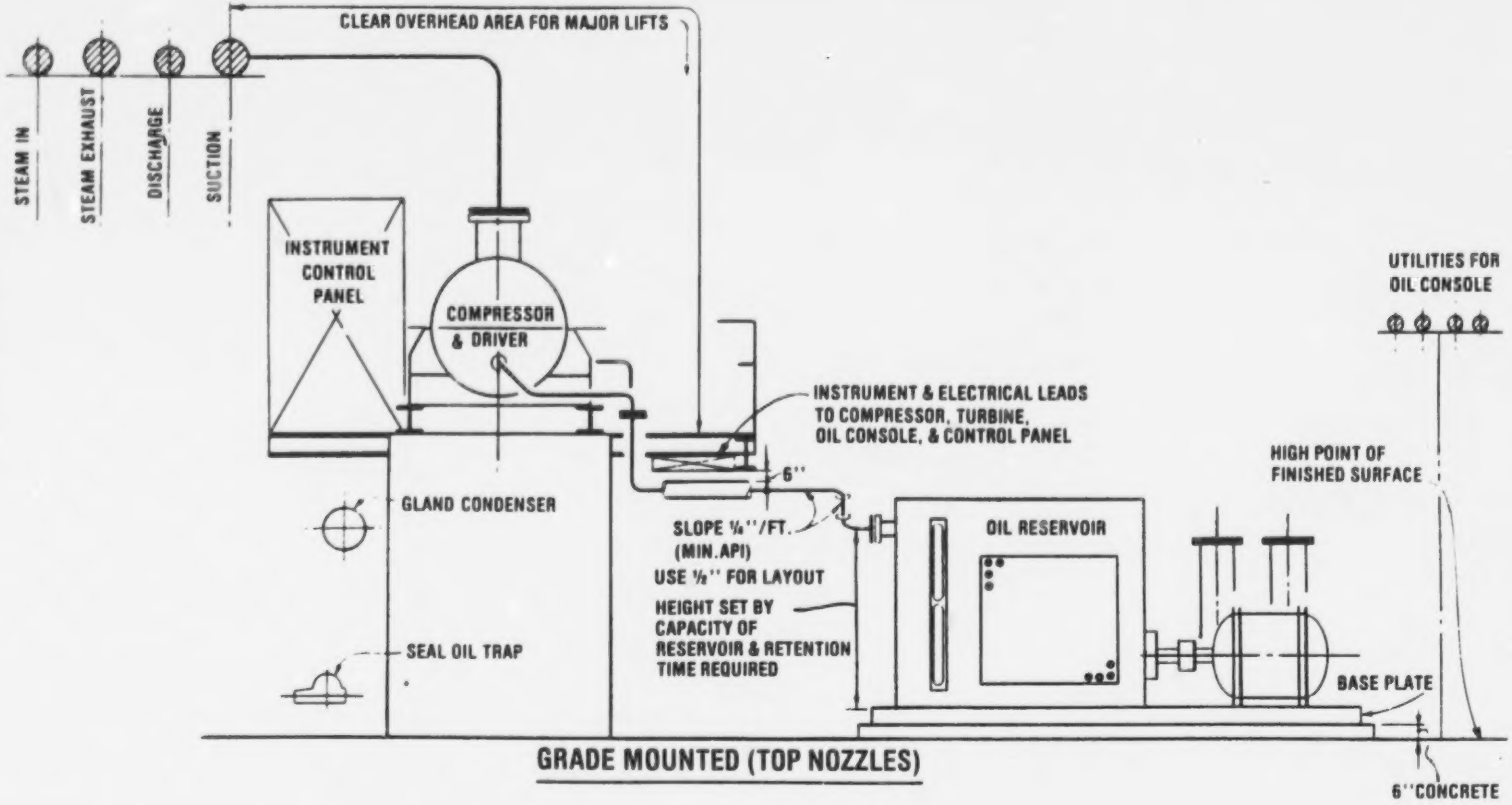
(Continued)


PIPEWAY
SUPPORT FROM HEATER SHELL OR PLATFORM STEEL (TYP)
DAMPER WHEEL (OPERATING CABLE EXTENDS TO GRADE PROVIDE CLEARANCE)
TUBE PULLING DOOR
TI
EACH OUTLET
TUBE REMOVAL

RADIANT TYPE
(TWO PASS)

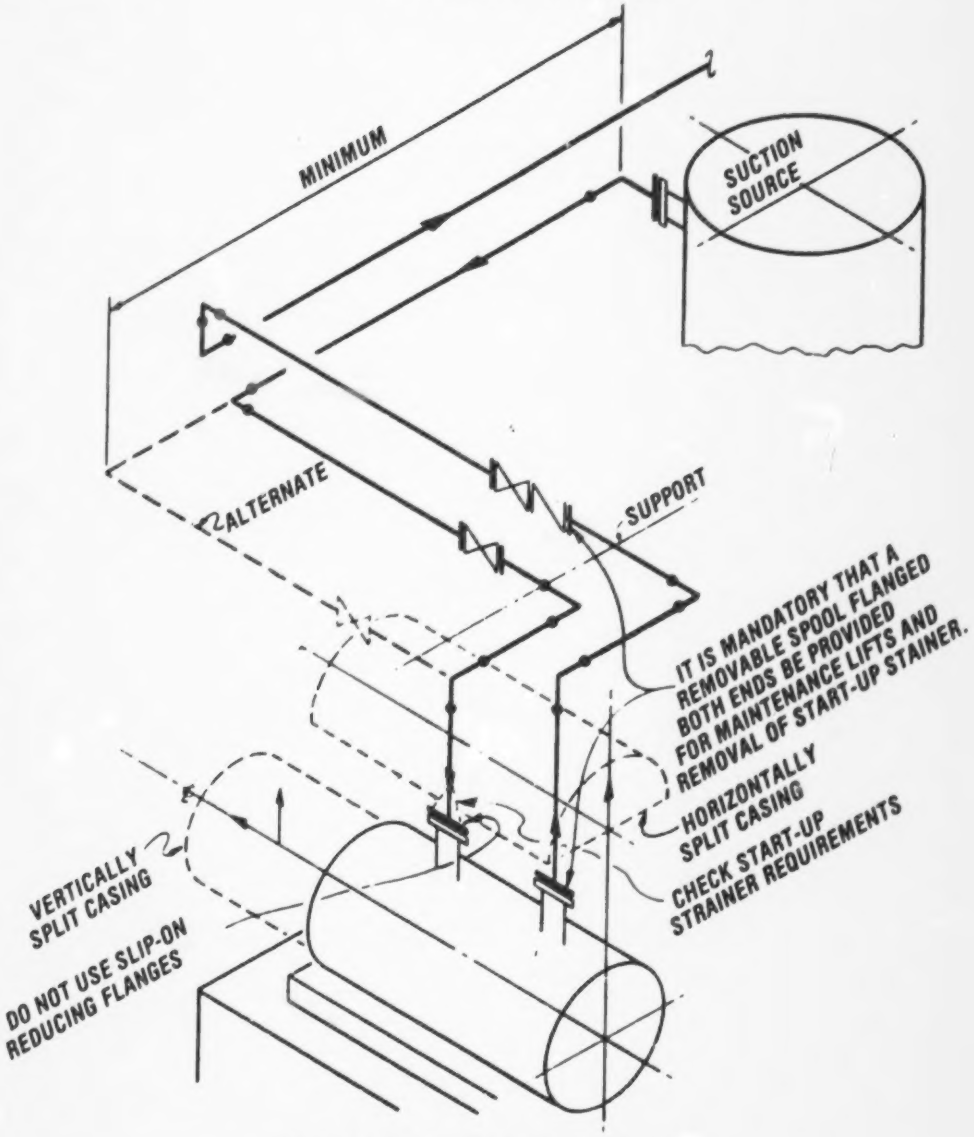
PLAN
TYPICAL PROCESS PIPING @ VERTICAL HEATER

Compressor Piping


CLEAR OVERHEAD AREA FOR MAJOR LIFTS
STEAM IN
STEAM EXHAUST
DISCHARGE
SUCTION
INSTRUMENT CONTROL PANEL
COMPRESSOR & DRIVER
UTILITIES FOR OIL CONSOLE
INSTRUMENT & ELECTRICAL LEADS TO COMPRESSOR, TURBINE, OIL CONSOLE, & CONTROL PANEL
HIGH POINT OF FINISHED SURFACE
6''
GLAND CONDENSER
SLOPE ¼''/FT. (MIN.API)
USE ½'' FOR LAYOUT
OIL RESERVOIR
HEIGHT SET BY CAPACITY OF RESERVOIR & RETENTION TIME REQUIRED
SEAL OIL TRAP
BASE PLATE
GRADE MOUNTED (TOP NOZZLES)
6''CONCRETE

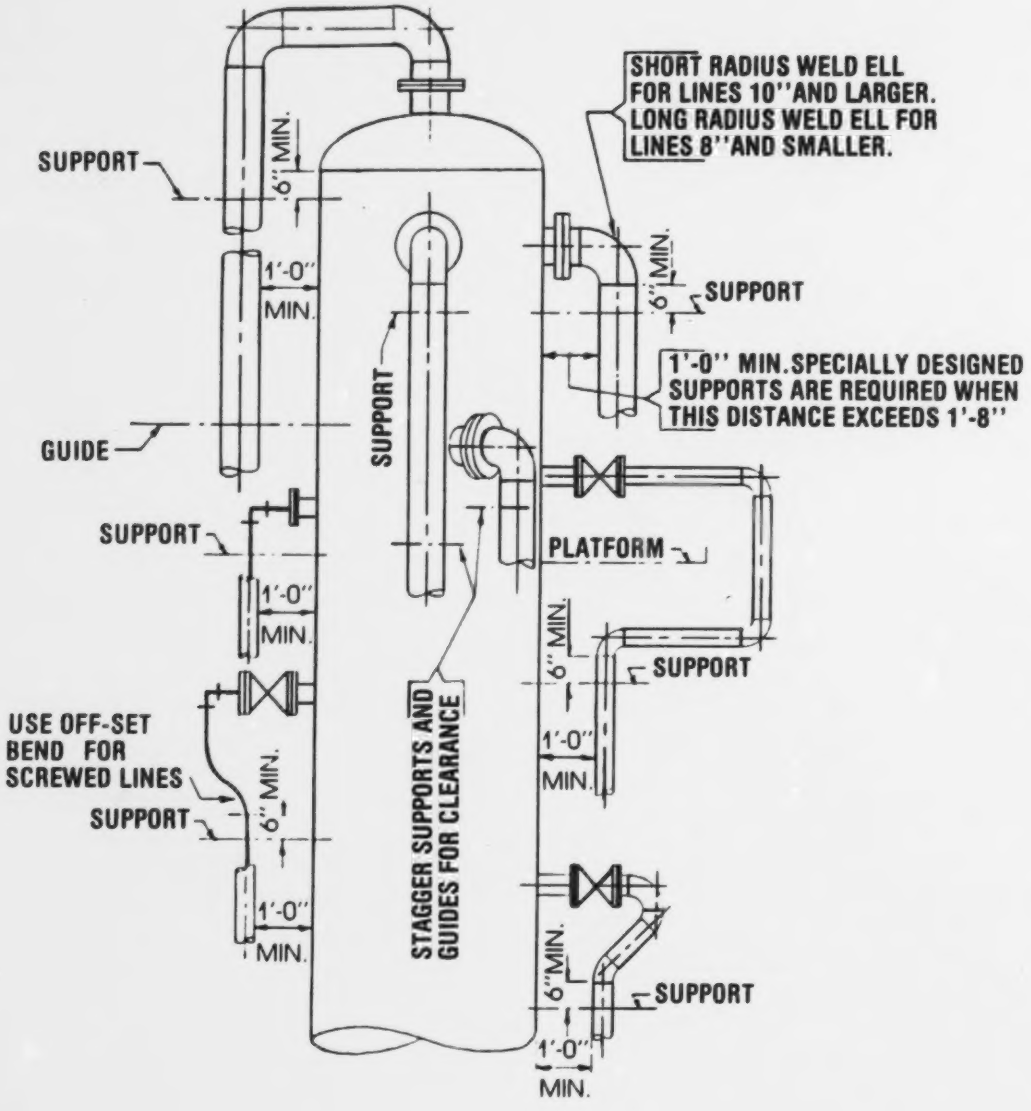
Compressor Piping
(Continued)

PICTORIAL VIEW

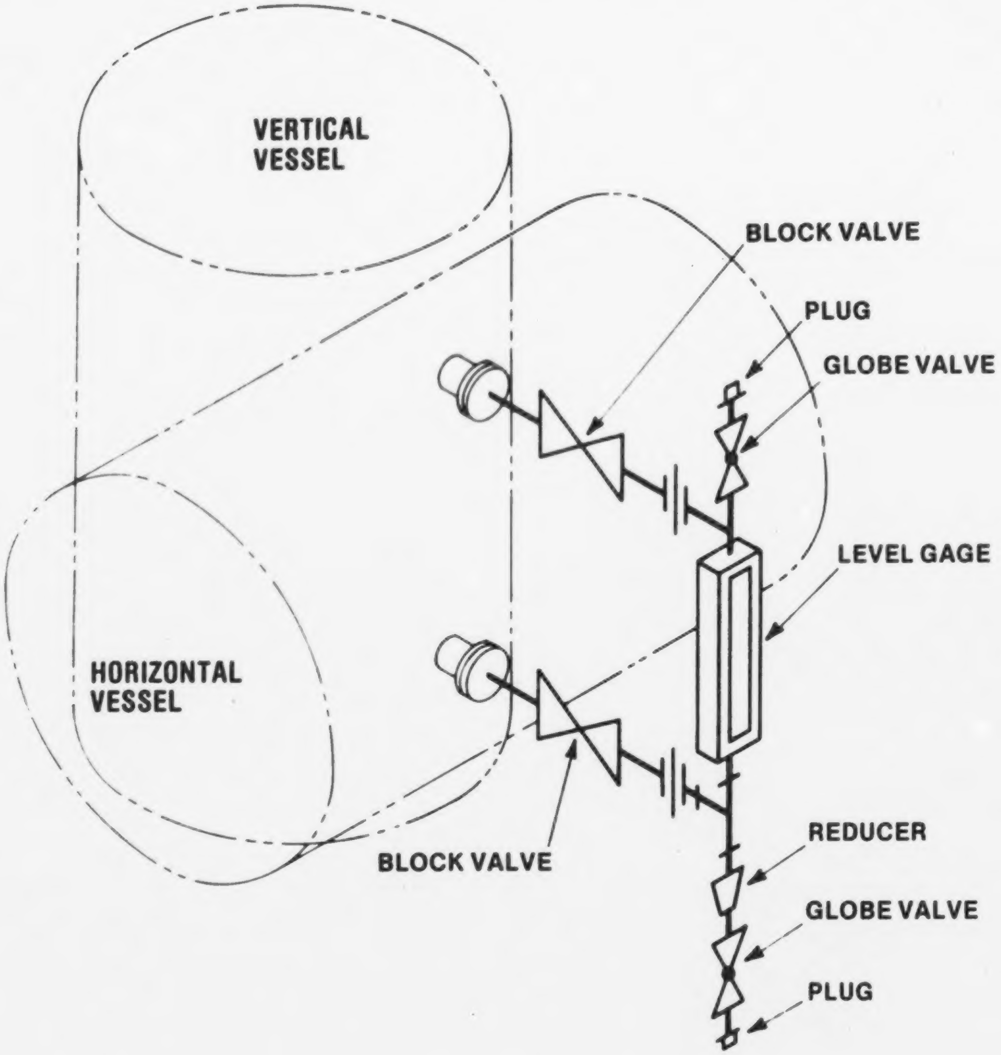

MINIMUM
SUCTION SOURCE
ALTERNATE
SUPPORT
IT IS MANDATORY THAT A REMOVABLE SPOOL FLANGED BOTH ENDS BE PROVIDED FOR MAINTENANCE LIFTS AND REMOVAL OF START-UP STAINER.
HORIZONTALLY SPLIT CASING
CHECK START-UP STRAINER REQUIREMENTS
VERTICALLY SPLIT CASING
DO NOT USE SLIP-ON REDUCING FLANGES

TOP NOZZLE ORIENTATION FOR HORIZONTALLY & VERTICALLY SPLIT CASING

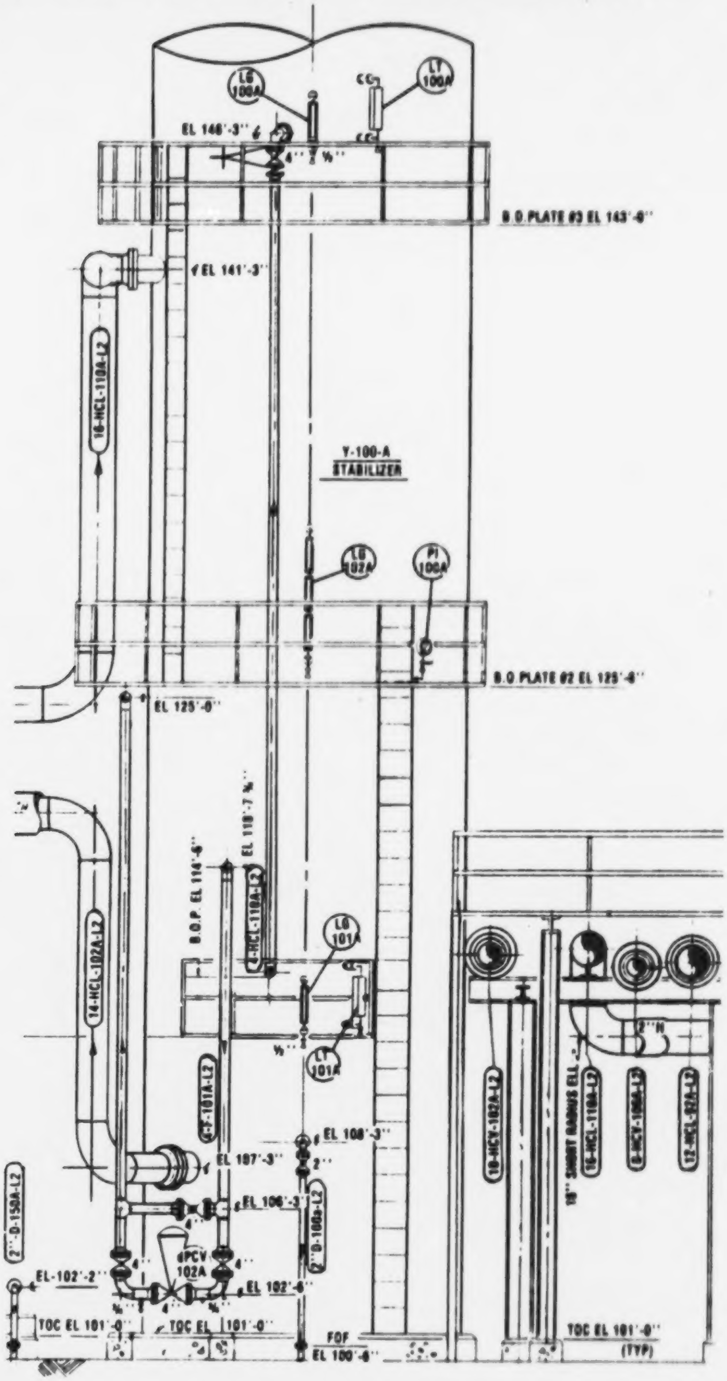
Column and Tower Piping


SHORT RADIUS WELD ELL
FOR LINES 10''AND LARGER.
LONG RADIUS WELD ELL FOR
LINES 8''AND SMALLER.
SUPPORT
6'' MIN.
6'' MIN.
SUPPORT
1'-0''
MIN.
1'-0'' MIN.SPECIALLY DESIGNED
SUPPORTS ARE REQUIRED WHEN
THIS DISTANCE EXCEEDS 1'-8''
SUPPORT
GUIDE
SUPPORT
PLATFORM
1'-0''
MIN.
6'' MIN.
SUPPORT
STAGGER SUPPORTS AND
GUIDES FOR CLEARANCE
1'-0''
MIN.
USE OFF-SET
BEND FOR
SCREWED LINES
6'' MIN.
SUPPORT
1'-0''
MIN.
6'' MIN.
SUPPORT
1'-0''
MIN.

Typical Level Instrument Connection

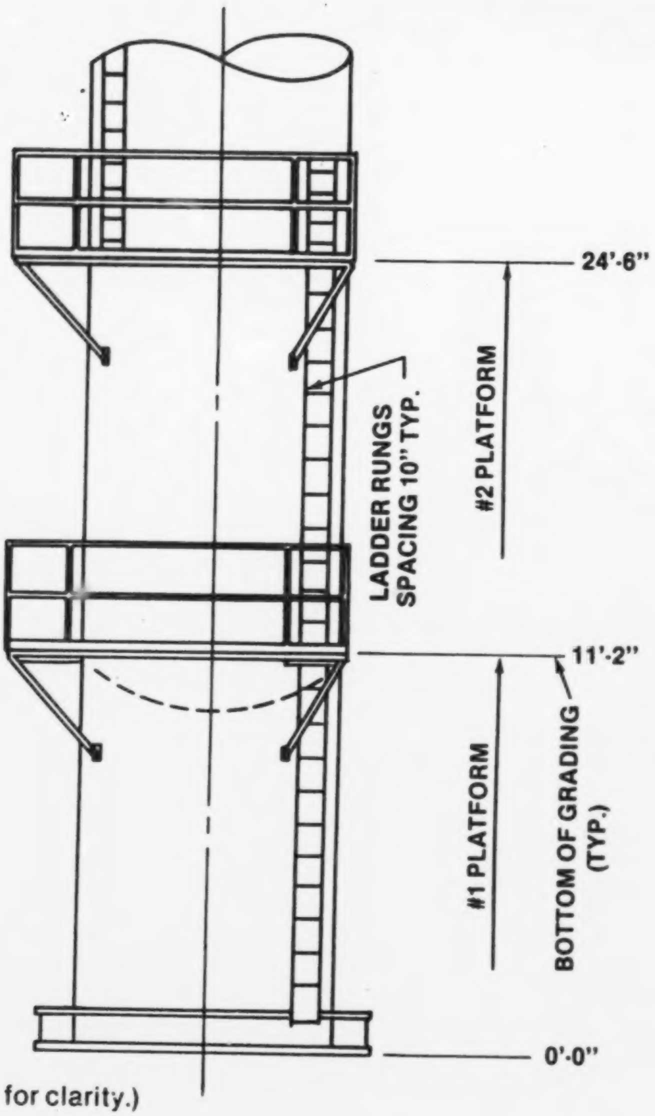

VERTICAL VESSEL
BLOCK VALVE
PLUG
GLOBE VALVE
LEVEL GAGE
HORIZONTAL VESSEL
BLOCK VALVE
REDUCER
GLOBE VALVE
PLUG

Typical Platform Elevation


LG 100A
LT 100A
EL 146'-3"
4" x ½"
B.O.PLATE #3 EL 143'-6"
EL 141'-3"
16-HCL-110A-L2
Y-100-A
STABILIZER
LG 102A
PI 100A
B.O PLATE #2 EL 125'-6"
EL 125'-0"
EL 118'-7 ¾"
B.O.P. EL 114'-6"
4-HCL-110A-L2
LG 101A
14-HCL-102A-L2
LT 101A
½"
4-T-101A-L2
EL 108'-3"
2"
EL 107'-3"
EL 106'-3"
2"-D-150A-L2
2"-D-160A-L2
4"
dPCV 102A
EL-102'-2"
EL 102'-6"
¾"
TOC EL 101'-0"
TOC EL 101'-0"
FOF EL 100'-6"
10-HCV-102A-L2
18" SHORT RADIUS ELL
16-HCL-110A-L2
8-HCV-106A-L2
12-HCL-92A-L2
2" H
TOC EL 101'-0" (TYP)

Courtesy of Phillips Petroleum Co.

Platforms and Ladders


24'-6"
LADDER RUNGS SPACING 10" TYP.
#2 PLATFORM
11'-2"
BOTTOM OF GRADING (TYP.)
#1 PLATFORM
0'-0"

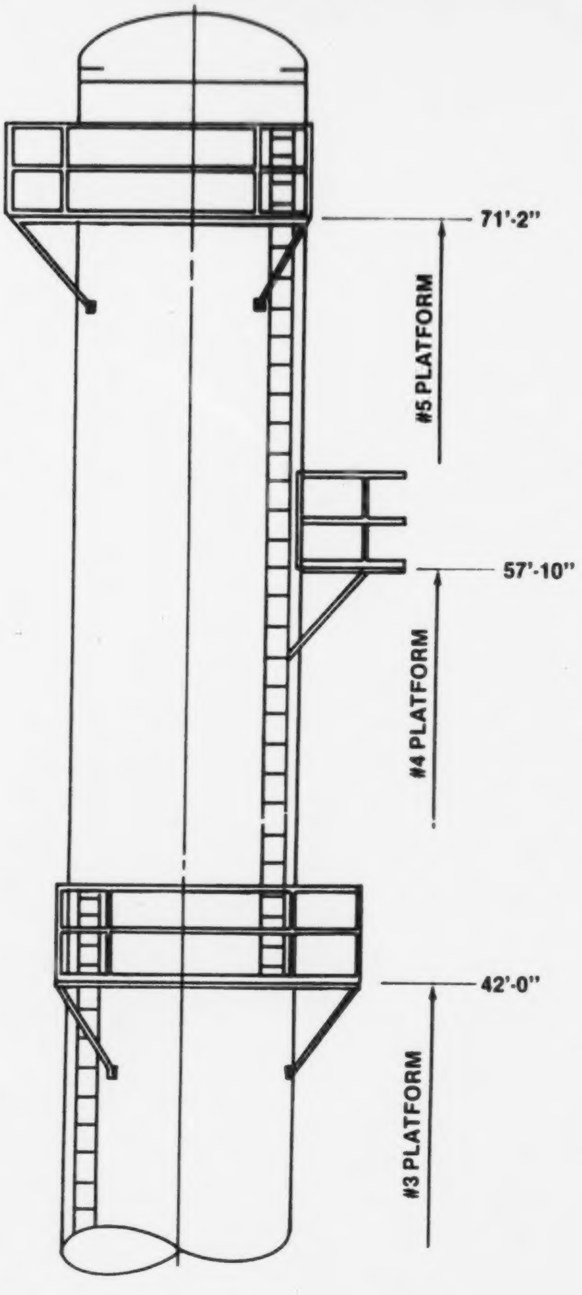
(NOTE: Cage is not shown for clarity.)

NORTH ELEVATION

616

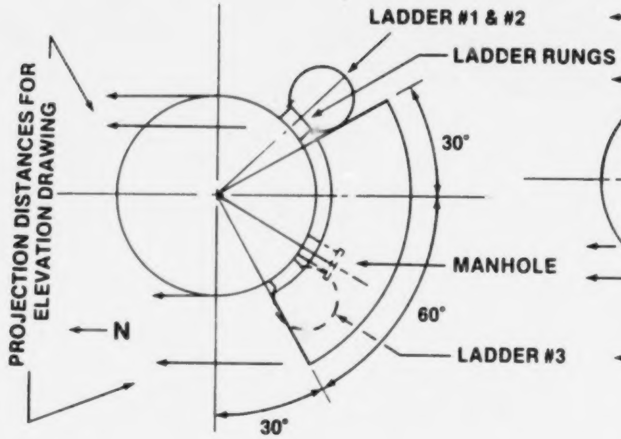
Platforms and Ladders

(Continued)

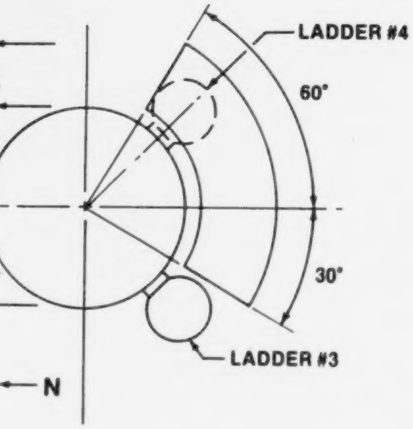

71'-2"
#5 PLATFORM
57'-10"
#4 PLATFORM
42'-0"
#3 PLATFORM

617

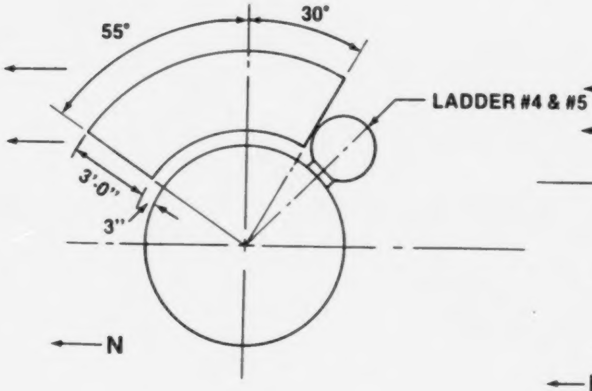
Platforms and Ladders
(Plan Views)


LADDER #1 & #2
LADDER RUNGS
PROJECTION DISTANCES FOR ELEVATION DRAWING
30°
MANHOLE
60°
LADDER #3
N
30°

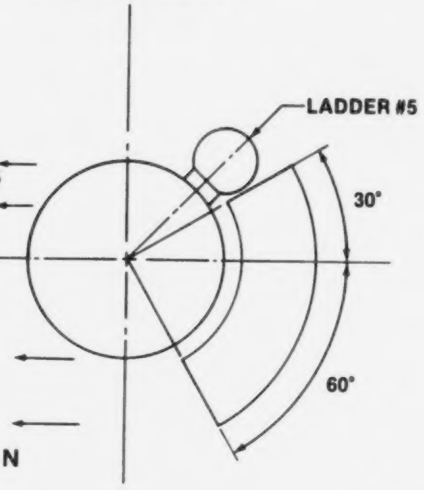
PLATFORM #1 & #2


LADDER #4
60°
30°
LADDER #3
N

PLATFORM #3


55°
30°
LADDER #4 & #5
3'-0"
3"
N

PLATFORM #4


LADDER #5
30°
60°
N

PLATFORM #5

Piping Design Fundamentals
Unit 8

Information Sheet

1. **Terms and definitions**

   a. **Base ell support** — Supports piping from the lower side of an elbow

   b. **Block valve** — Any valve that does not regulate or throttle flow

   c. **Bridle/manifold** — A common line used for manifolding multiple instruments to one pair of connections on a vessel

   d. **Bypass pipe** — A pipe loop which provides partial or full flow of material around a piece of equipment or valve station

   e. **Bypass valve** — A small diameter pipe connected from inlet to outlet side of a valve with its own small valve to allow line contents to pass to the other side of a disk or gate to equalize pressure for ease of operation

   f. **Centrifugal compressor** — A compressor used to increase pressure by centrifugal force

   g. **Compressor bottle** — A device used to eliminate pulsation in a line

   h. **Control station** — A pipe loop consisting of a control valve, various fittings, and block valves to regulate the flow, pressure, or quantity of material at a predetermined location

   i. **Dummy leg** — A piece of pipe or rolled steel welded to another piece of pipe to support the weight of a line

   j. **Manifold (header)** — A main line pipe with several connections

   k. **Main line** — The primary section of a piping system which contains the process fluid or major service

   l. **Pipe loop** — A straight piece of pipe bent to a radii to receive an angle of 180° to 360°

   m. **Reciprocating compressor** — A compressor with several pistons in motion; used to increase power

   n. **Strainer** — Perforated flat or conical metal inserted between flanges upstream from pumps to filter out impurities that might damage the equipment or the product

   o. **Stuffing steam** — Steam used to extinguish a fire caused by tube rupture or to purge a heater before lighting

Information Sheet

2. Main control station components and their functions

a. **Control valve** — Usually an electronically controlled valve used to throttle flow in relation to temperature, pressure, or flow itself

b. **Bypass valve** — A valve tied into a control valve to open and close as needed to keep temperature, pressure, or flow from exceeding design standards

c. **Check valve** — Keeps flow from reversing

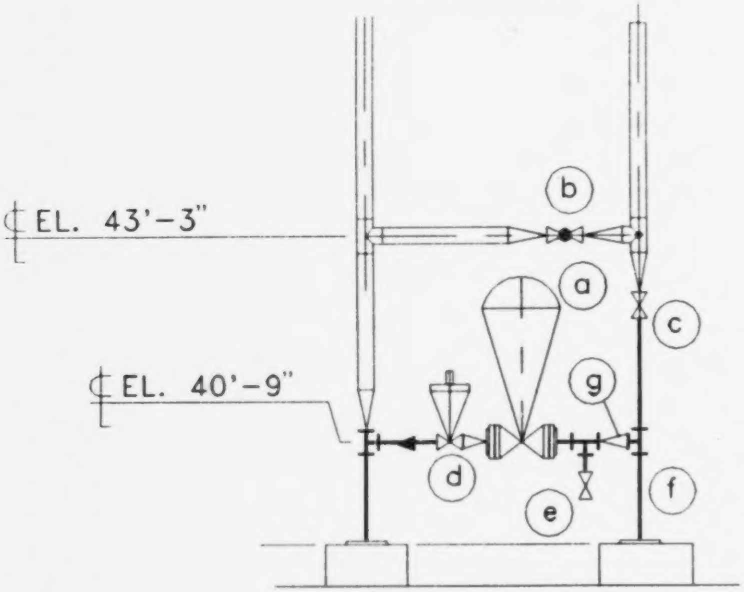
d. **Gate Valve** — Shuts off flow for service

e. **Drain** — Releases air during start up or shut down, and also used for taking samples

f. **Dummy leg** — Supports weight of pipe and liquid so station will not bear weight or shock

g. **Reducers** — Placed on both sides of a control valve to finsure proper measurements

Main Components of a Control Station



SECTION "B-B"
DWG. 4037

Information Sheet

3. Guidelines for sizing and dimensioning a control station

a. Design the control valve smaller than the main line, and design the bypass valves with the same capacity as the control valve.

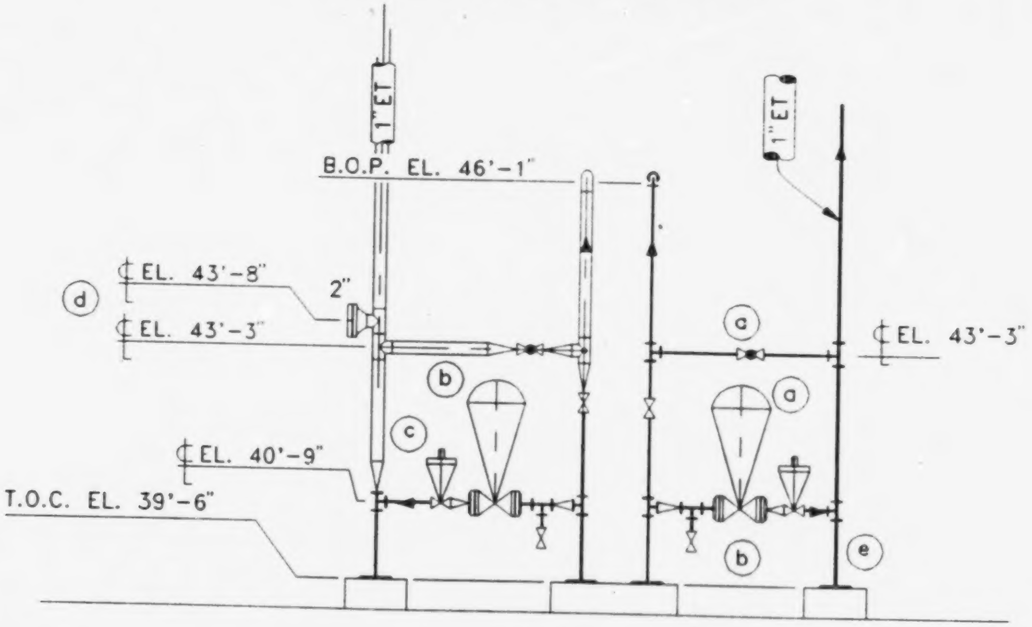
b. Allow maintenance clearance space between the bottom of the control valve and the actual grade or platform, and a minimum 12′ clearance between the top of the actuator and any fixture directly above the diaphragm case.

c. Allow a 6″ minimum clearance between a handwheel and vertical lines or flanges, and increase the clearance by a distance equal to the thickness of insulation if insulation is used.

d. Dimension the vertical location of all valves and the horizontal location of flanged and welded-end valves.

e. Support the control station so that the control valve can be removed and serviced without disturbing the surrounding pipe.

Sizing and dimensioning a control station



SECTION "B-B"
DWG 4037

Information Sheet

4. Piping for pumps

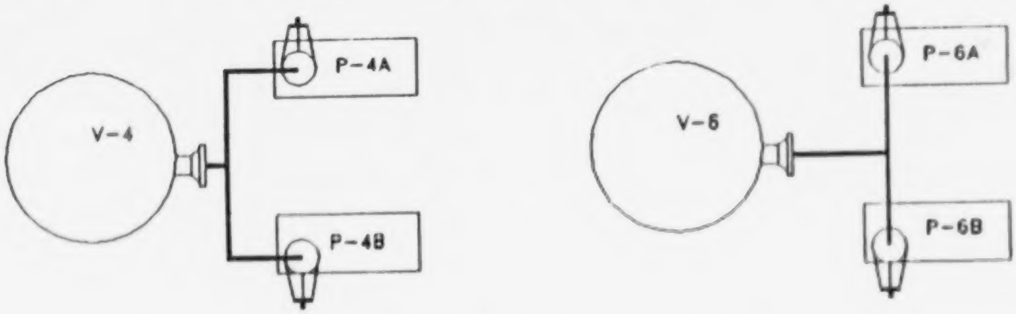
a. Flow should never rise before entering a pump; always feed a pump from an overhead source.

b. When suction side or discharge side piping interferes with pump connections, make offsets to allow for connection on the discharge side only.

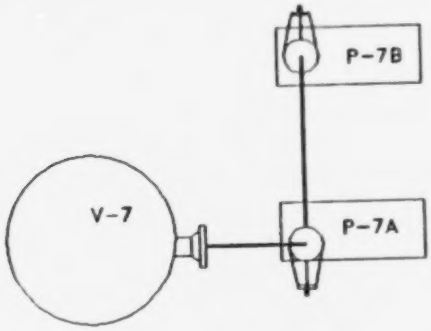
c. Since pumps require more maintenance than vessels, and motors require periodic replacement, provide sufficient areas for maintenance and access.

d. Install pumps in pairs so one can be used as backup in conjunction with bypass lines so flow can continue while a pump is being serviced.

Examples 1 and 2: Piping when the vessel outlet is at the same elevation as the suction inlet on a pump

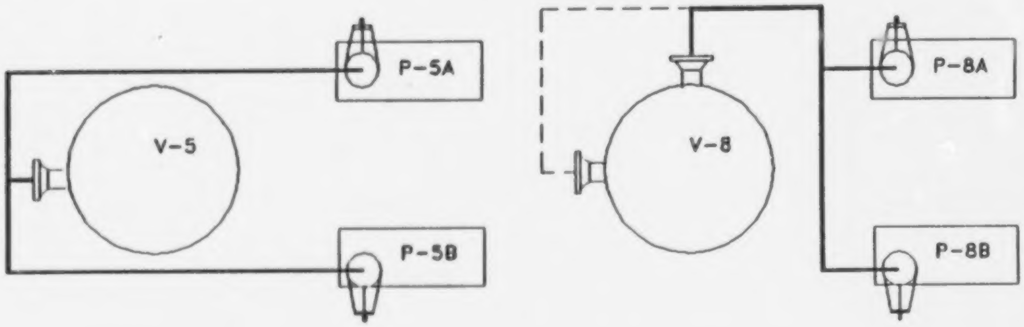


Example 3: Piping when the pump arrangement is for a vessel with a nozzle higher than the pump suction inlet



Information Sheet

Examples 4 and 5: Suggested arrangements when hot liquids are being handled; the longer flow allows for a slight cooling and compression of flow


P-5A
V-5
P-5B
P-8A
V-8
P-8B

5. Guidelines for piping heat exchangers

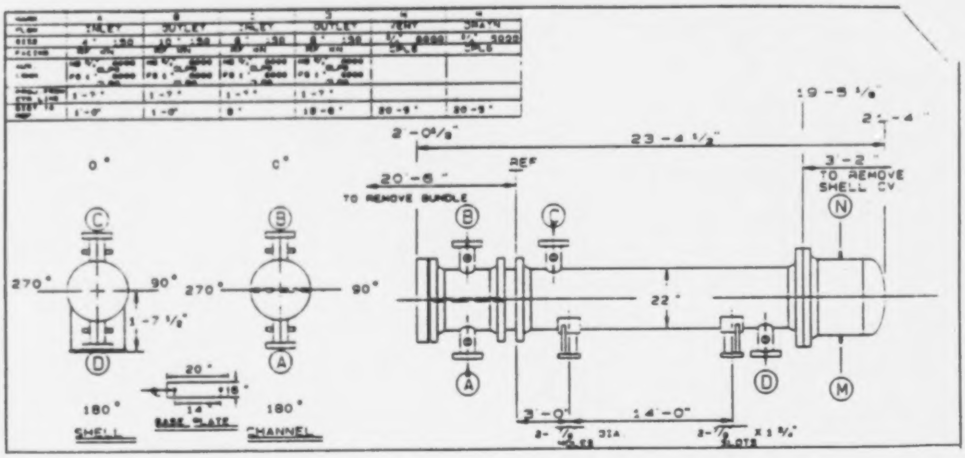
a. Check manufacturer's drawings for shell and tube, inlet and outlet, and sizes and locations.

b. Design exchanger piping so that it does not interfere with bundle or shell removal.

c. Flange all vessel connections for easy access, maintenance, and replacement.

d. Design lines so that fluids being heated will flow up, and fluids being cooled will flow down.

Heat exchanger dimensional outline


0°
270°
90°
180°
SHELL
C
D
1'-7 1/8"
20"
18"
14"
BASE PLATE
B
A
CHANNEL
2'-0⅝"
23'-4 1/2"
19'-5 1/8"
3'-2"
TO REMOVE SHELL CV
20'-6"
TO REMOVE BUNDLE
REF
N
M
22"
3'-0"
14'-0"
HOLES
DIA
SLOTS

Courtesy CUST-O-FAB INC.

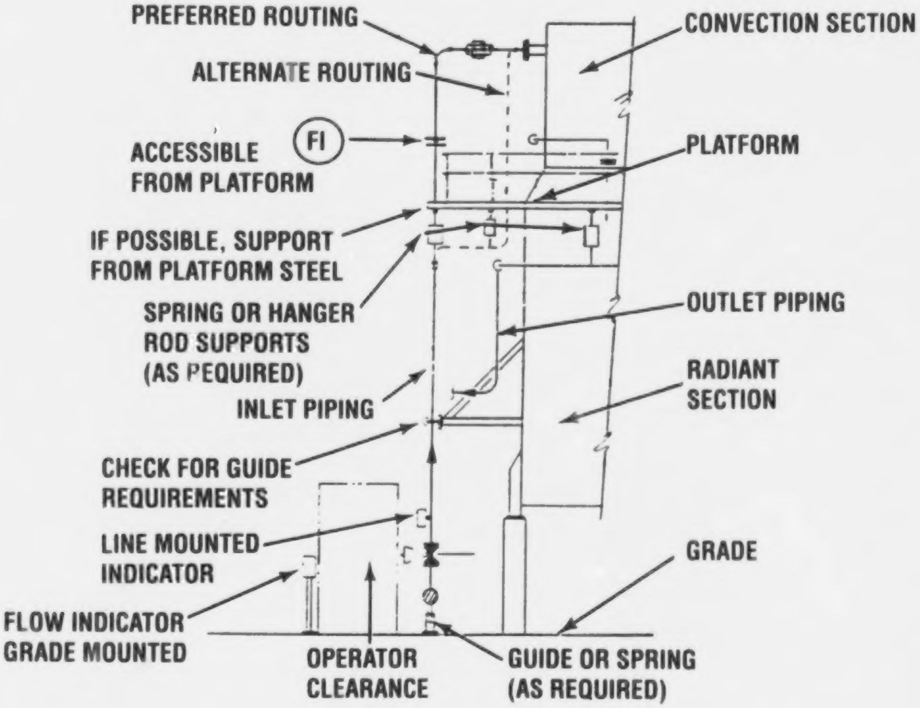
Information Sheet

6. Guidelines for piping fired heaters

a. Always consult manufacturer's piping specifications before designing piping because heaters operate at high temperatures and the proper location of safety shut off equipment is critical.

b. Support inlet and outlet piping as close to the heater as possible, and always calculate thermal expansion into pipe lengths.

Horizontal fired heater piping


PREFERRED ROUTING
CONVECTION SECTION
ALTERNATE ROUTING
FI
ACCESSIBLE FROM PLATFORM
PLATFORM
IF POSSIBLE, SUPPORT FROM PLATFORM STEEL
SPRING OR HANGER ROD SUPPORTS (AS PEQUIRED)
OUTLET PIPING
RADIANT SECTION
INLET PIPING
CHECK FOR GUIDE REQUIREMENTS
LINE MOUNTED INDICATOR
GRADE
FLOW INDICATOR GRADE MOUNTED
OPERATOR CLEARANCE
GUIDE OR SPRING (AS REQUIRED)

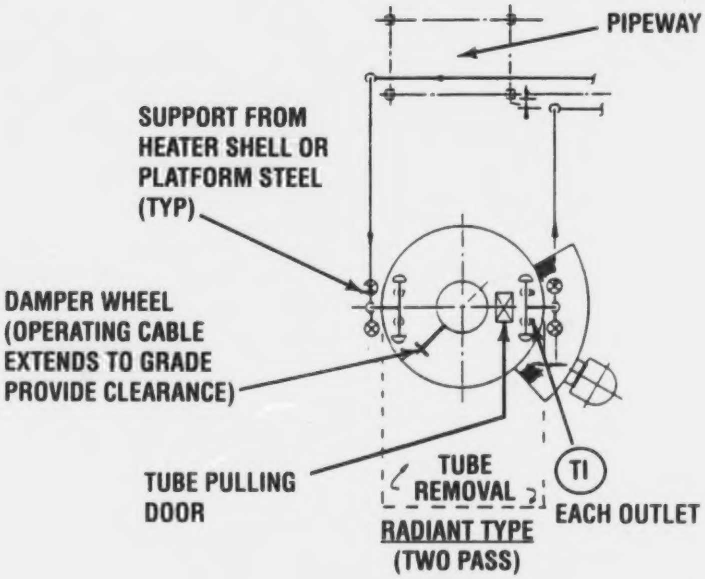
c. For best support, route lines in groups as close to the heater structural members as possible.

d. Insulate piping with fire-proof materials, and keep piping clear of all peep holes, access doors, and burner removal spaces.

Information Sheet

e. Because heaters produce vibration, it is usually best to support piping with vibration reducing components.

Vertical fired heater piping


PIPEWAY
SUPPORT FROM HEATER SHELL OR PLATFORM STEEL (TYP)
DAMPER WHEEL (OPERATING CABLE EXTENDS TO GRADE PROVIDE CLEARANCE)
TUBE PULLING DOOR
TUBE REMOVAL
TI
EACH OUTLET
RADIANT TYPE
(TWO PASS)

PLAN

TYPICAL PROCESS PIPING @ VERTICAL HEATER

7. Guidelines for piping gas compressors

a. Design compressor inlet piping so that it is higher than the compressor inlet.

b. Design all compressor piping to prevent pocketing and low spots in the lines where condensate could build up and severely damage compressor equipment.

c. Make all inlet and discharge lines as straight as possible with no 90° turns or sharp direction changes near the compressor.

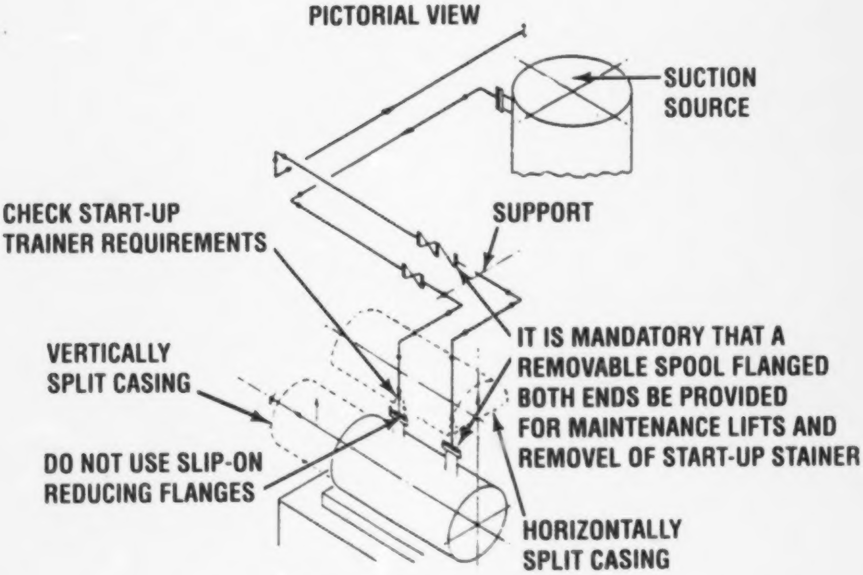
d. Locate all piping clear of compressor rotor removal area or access doors.

e. Place bottles on the inlet side of compressors to reduce line shock.

Information Sheet

f. Locate support fittings and valves to reduce surge and vibration.

Compressor piping


PICTORIAL VIEW
SUCTION SOURCE
CHECK START-UP TRAINER REQUIREMENTS
SUPPORT
VERTICALLY SPLIT CASING
IT IS MANDATORY THAT A REMOVABLE SPOOL FLANGED BOTH ENDS BE PROVIDED FOR MAINTENANCE LIFTS AND REMOVEL OF START-UP STAINER
DO NOT USE SLIP-ON REDUCING FLANGES
HORIZONTALLY SPLIT CASING

TOP NOZZLE ORIENTATION FOR HORIZONTALLY & VERTICALLY SPLIT CASING

8. Guidelines for piping columns, accumulators, and storage vessels

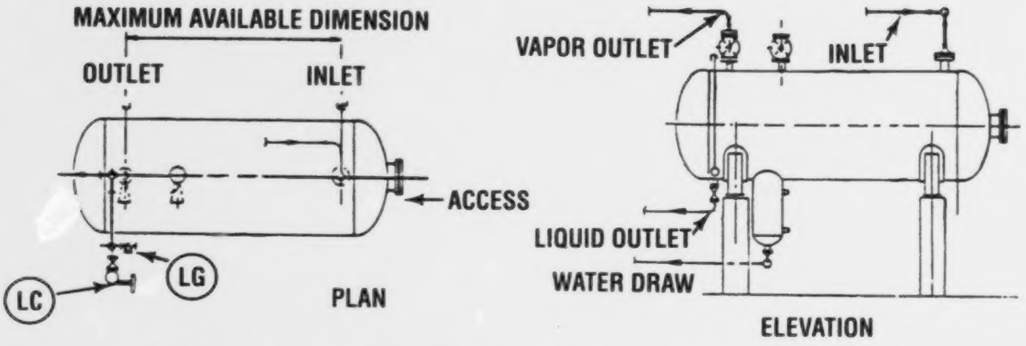
a. When valves are connected to vessels, place them directly onto the nozzle if possible.

b. Unless otherwise specified, use flanged steel valves because they are fire proof and less expensive than many other types of valves.

Information Sheet

c. Allow for placement of drains and vents in all lines.

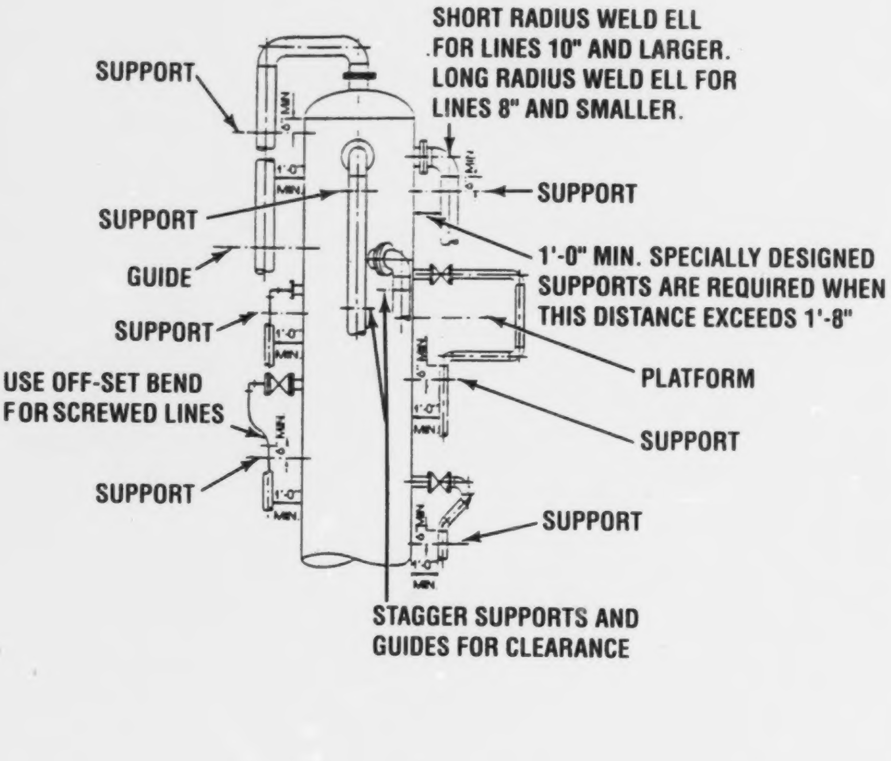
Accumulator and vessel piping


MAXIMUM AVAILABLE DIMENSION
OUTLET
INLET
ACCESS
LG
LC
PLAN
VAPOR OUTLET
INLET
LIQUID OUTLET
WATER DRAW
ELEVATION

d. Provide for thermal expansion on outlet lines.

e. Design platforms at all access points if a column is over 5′-0″ high.

Column and tower piping


SHORT RADIUS WELD ELL FOR LINES 10" AND LARGER. LONG RADIUS WELD ELL FOR LINES 8" AND SMALLER.
SUPPORT
SUPPORT
SUPPORT
GUIDE
1'-0" MIN. SPECIALLY DESIGNED SUPPORTS ARE REQUIRED WHEN THIS DISTANCE EXCEEDS 1'-8"
SUPPORT
PLATFORM
USE OFF-SET BEND FOR SCREWED LINES
SUPPORT
SUPPORT
SUPPORT
1'-0" MIN.
STAGGER SUPPORTS AND GUIDES FOR CLEARANCE

Information Sheet

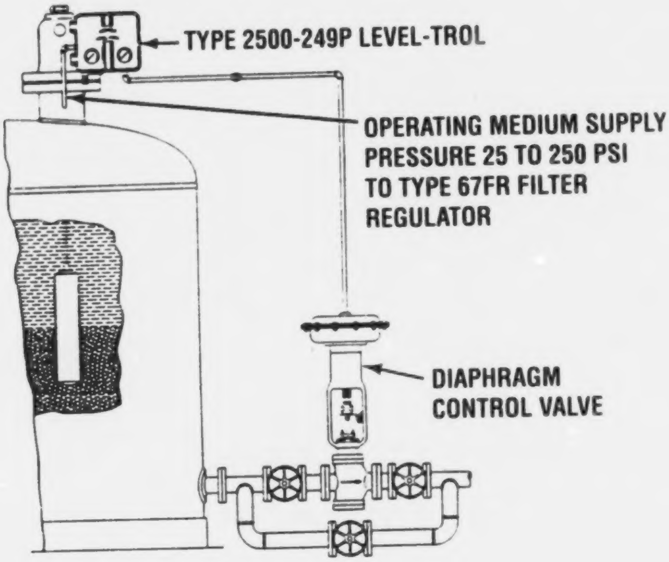
9. Piping liquid level instruments

a. Liquid level instruments control levels in vessels by controlling inlet and outlet flow.

b. Liquid level instruments are also used to monitor and record liquid level in vessels.

c. In general, liquid level piping uses two flanged connections to attach to vessels.

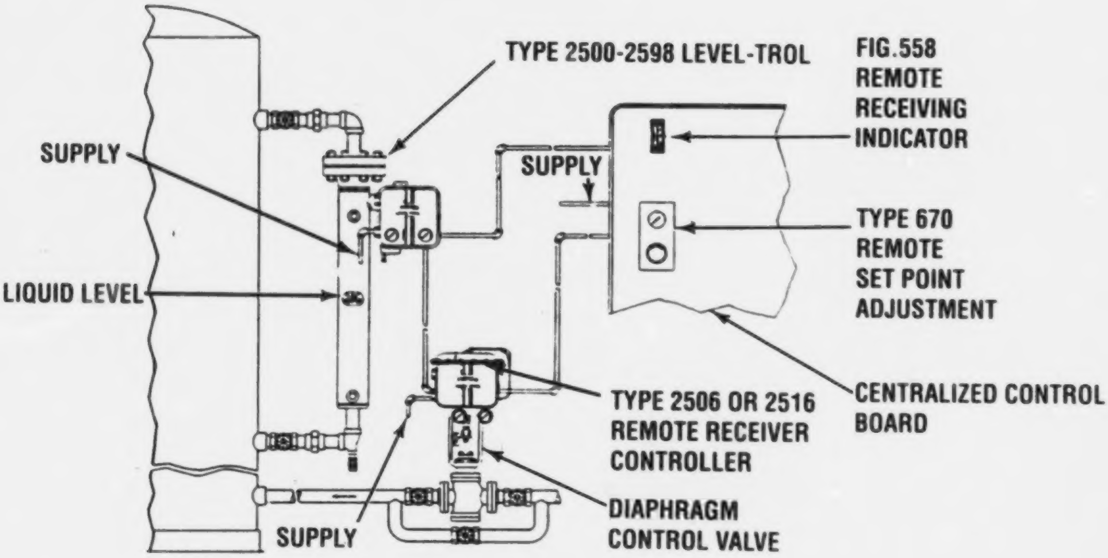
d. A common piping application is to have a top-mounted level gauge with a bottom-mounted outlet control.


TYPE 2500-249P LEVEL-TROL
OPERATING MEDIUM SUPPLY PRESSURE 25 TO 250 PSI TO TYPE 67FR FILTER REGULATOR
DIAPHRAGM CONTROL VALVE

Courtesy Fisher Controls

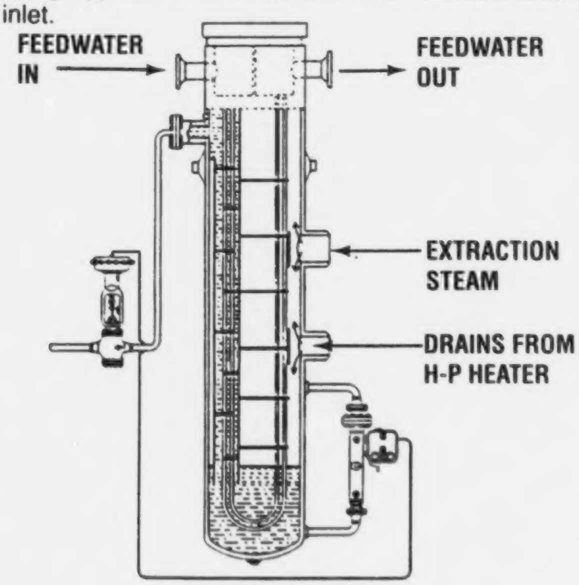
Information Sheet

e. Another piping application is to have a side-mounted level gauge with a bottom-mounted inlet.


TYPE 2500-2598 LEVEL-TROL
FIG.558 REMOTE RECEIVING INDICATOR
SUPPLY
SUPPLY
TYPE 670 REMOTE SET POINT ADJUSTMENT
LIQUID LEVEL
CENTRALIZED CONTROL BOARD
TYPE 2506 OR 2516 REMOTE RECEIVER CONTROLLER
DIAPHRAGM CONTROL VALVE
SUPPLY

Courtesy Fisher Controls

f. Another piping application is to have a side-mounted level gauge with a top-mounted inlet.

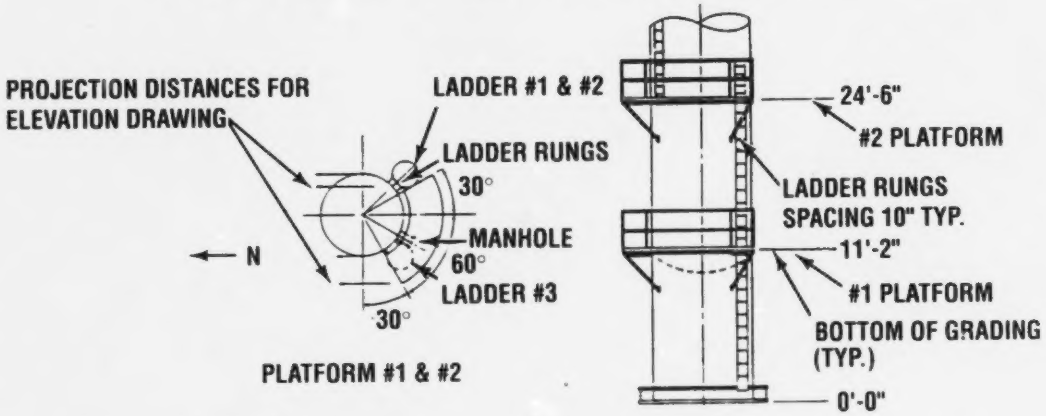

FEEDWATER IN
FEEDWATER OUT
EXTRACTION STEAM
DRAINS FROM H-P HEATER

Courtesy Fisher Controls

Information Sheet

10. Guidelines for drawing ladders and platforms

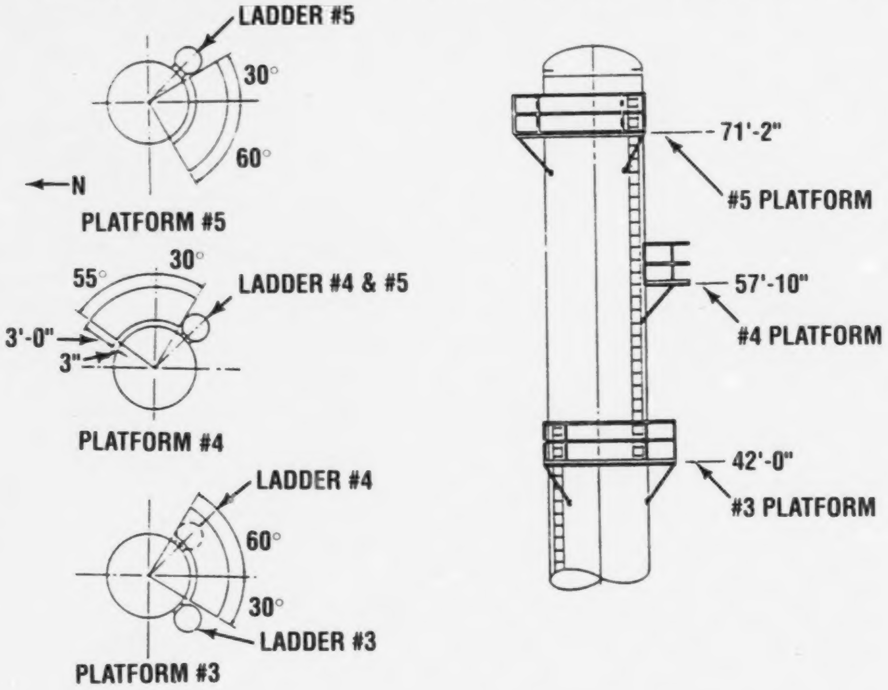
a. Design platforms for elevations above 15′-0″ to provide maintenance and inspection access for manways, nozzles, peep holes, and control stations.


PROJECTION DISTANCES FOR ELEVATION DRAWING
LADDER #1 & #2
LADDER RUNGS
30°
MANHOLE
60°
LADDER #3
30°
N
PLATFORM #1 & #2
24'-6"
#2 PLATFORM
LADDER RUNGS SPACING 10" TYP.
11'-2"
#1 PLATFORM
BOTTOM OF GRADING (TYP.)
0'-0"

b. Design platforms with a minimum 2′-6″ walking space.

c. Provide safety cages for all elevations above 8′-0″.

d. Label platforms in order from the lowest to the highest from elevation of grating.


LADDER #5
30°
60°
N
PLATFORM #5
55°
30°
LADDER #4 & #5
3'-0"
3"
PLATFORM #4
LADDER #4
60°
30°
LADDER #3
PLATFORM #3
71'-2"
#5 PLATFORM
57'-10"
#4 PLATFORM
42'-0"
#3 PLATFORM

Piping Design Fundamentals
Unit 8

Assignment Sheet 1—Construct Ladder and Circular Platform Outline Drawings

Name ______________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Nozzle oriented from flow diagram	______
Platforms correct and sketched on plan view	______
Platforms and ladders shown in elevation view	______
Handrails constructed to standards	______

Directions: Lay out the platforms and ladders on a tower elevation using the following procedure. Sample drawings of vessels, handrails, ladders, and platforms are included for reference. You will also find a sample of a typical platform ladder layout for one tower. Check with your instructor for available vendor drawings to further assist you with this assignment.

CAD Alert: Here's a situation where your CAD station can help you plan ahead. You will need to reference your outline drawings in the next assignment sheet, so make your drawings accurate so you can save and retrieve them to help with the next activity.

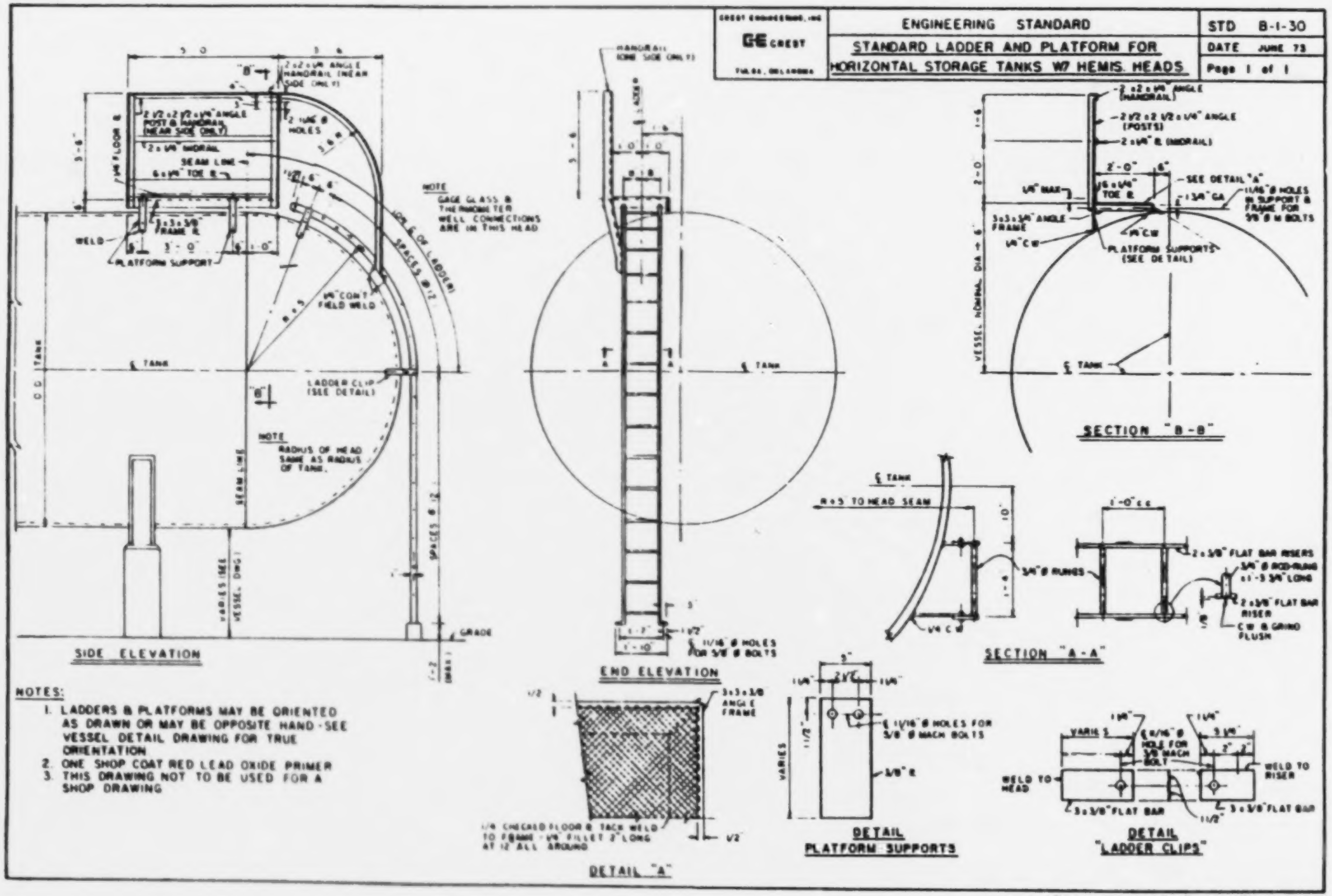
Procedure:

1. Obtain O.D. of tower from vendor drawings.
2. Orient nozzles from flow diagram, tower nozzle orientation plan, and connection schedule.
3. Locate platforms at flanged nozzles, manholes, and instrumentation as required.
4. Construct plan view sketch of platforms for projection dimensions on elevation and plan drawings.
5. Construct single line drawing of platforms and ladders in elevation views.
6. Construct handrails as single line using handrail standards.

Assignment Sheet 1

Problem: Construct the required platforms and ladders of the given tower. Use scale of 3/8" = 1'-0" and construct on "C" size vellum. The tower height will exceed the paper height; therefore, break and draw the top adjacent to lower section.

Assignment Sheet 1


SIDE ELEVATION
END ELEVATION
SECTION "B-B"
SECTION "A-A"
DETAIL "A"
DETAIL PLATFORM SUPPORTS
DETAIL "LADDER CLIPS"
2 x 2 x 1/4" ANGLE HANDRAIL (NEAR SIDE ONLY)
2 1/2 x 2 1/2 x 1/4" ANGLE POST & HANDRAIL (NEAR SIDE ONLY)
2 x 1/4" MIDRAIL
SEAM LINE
6 x 1/4" TOE R
3 x 3 x 3/8" FRAME R
WELD
PLATFORM SUPPORT
1/4" CONT. FIELD WELD
LADDER CLIP (SEE DETAIL)
NOTE GAGE GLASS & THERMOMETER WELL CONNECTIONS ARE IN THIS HEAD
NOTE RADIUS OF HEAD SAME AS RADIUS OF TANK
SPACES @ 12"
℄ TANK
O.D. TANK
GRADE
HANDRAIL (ONE SIDE ONLY)
11/16" Ø HOLES FOR 5/8" Ø BOLTS
2 x 2 x 1/4" ANGLE (HANDRAIL)
2 1/2 x 2 1/2 x 1/4" ANGLE (POSTS)
2 x 1/4" R (MIDRAIL)
SEE DETAIL "A"
11/16" Ø HOLES IN SUPPORT & FRAME FOR 5/8" Ø M BOLTS
3 x 3 x 3/8" ANGLE FRAME
PLATFORM SUPPORTS (SEE DETAIL)
VESSEL NORMAL DIA + 6"
R + 3 TO HEAD SEAM
3/4" Ø RUNGS
2 x 3/8" FLAT BAR RISERS
3/4" Ø ROD-RUNG x 1'-3 3/4" LONG
2 x 3/8" FLAT BAR RISER
CW & GRIND FLUSH
3 x 3 x 3/8 ANGLE FRAME
1/4 CHECKED FLOOR R TACK WELD TO FRAME - 1/4" FILLET 2" LONG AT 12" ALL AROUND
11/16" Ø HOLES FOR 5/8" Ø MACH BOLTS
3/8" R
VARIES
WELD TO HEAD
WELD TO RISER
3 x 3/8" FLAT BAR

CREST ENGINEERING, INC.
CE CREST
TULSA, OKLAHOMA

ENGINEERING STANDARD

STANDARD LADDER AND PLATFORM FOR HORIZONTAL STORAGE TANKS W/ HEMIS. HEADS

STD B-1-30
DATE JUNE 73
Page 1 of 1

NOTES:
1. LADDERS & PLATFORMS MAY BE ORIENTED AS DRAWN OR MAY BE OPPOSITE HAND - SEE VESSEL DETAIL DRAWING FOR TRUE ORIENTATION
2. ONE SHOP COAT RED LEAD OXIDE PRIMER
3. THIS DRAWING NOT TO BE USED FOR A SHOP DRAWING

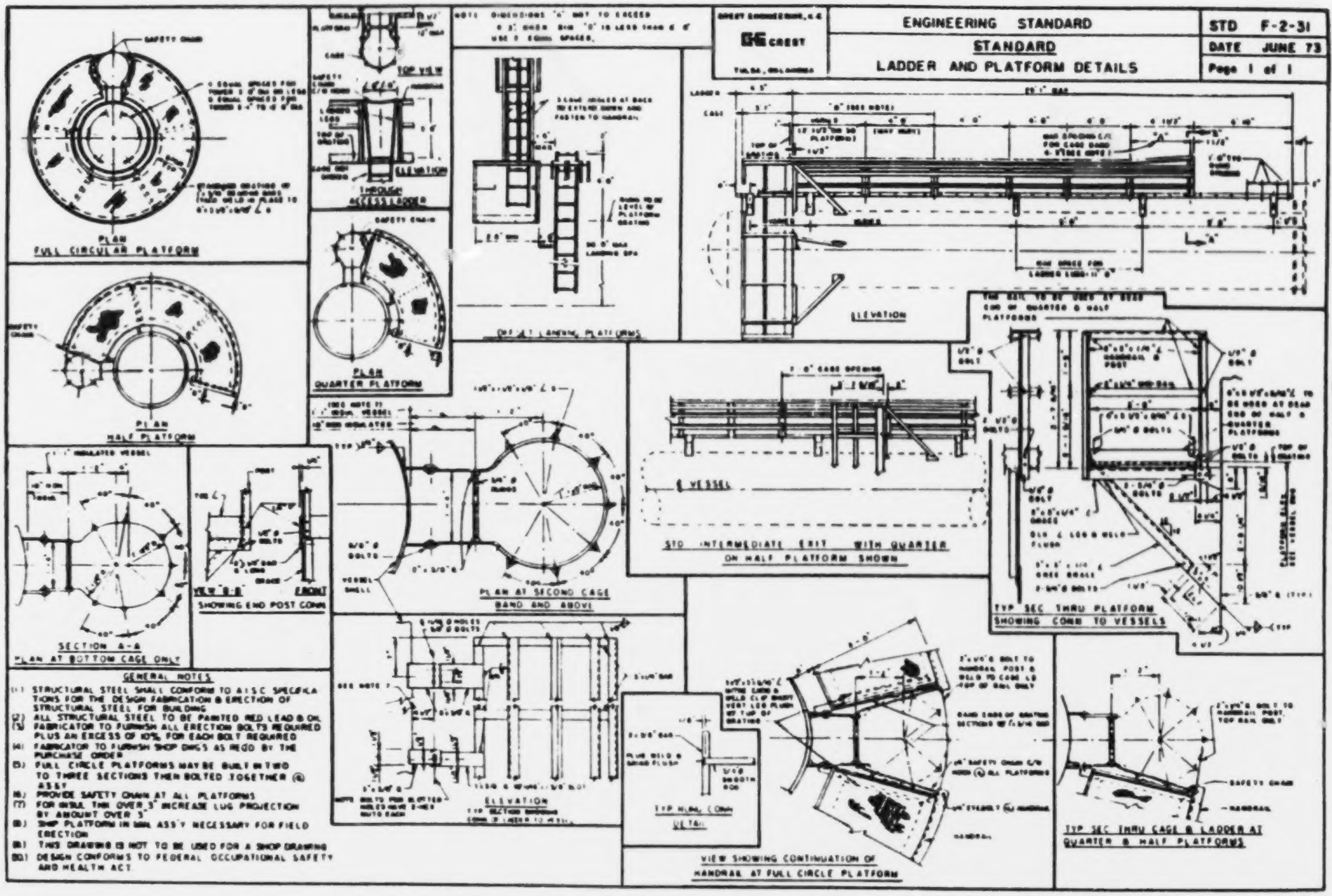
Courtesy of Crest Engineering

633

BEST COPY AVAILABLE

634

Assignment Sheet 1


CREST ENGINEERING, INC.
CE CREST
TULSA, OKLAHOMA
ENGINEERING STANDARD
STANDARD
LADDER AND PLATFORM DETAILS
STD F-2-31
DATE JUNE 73
Page 1 of 1
SAFETY CHAIN
PLAN
FULL CIRCULAR PLATFORM
PLAN
HALF PLATFORM
TOP VIEW
ELEVATION
THROUGH ACCESS LADDER
PLAN
QUARTER PLATFORM
OFFSET LANDING PLATFORMS
ELEVATION
STD INTERMEDIATE EXIT WITH QUARTER OR HALF PLATFORM SHOWN
℄ VESSEL
TYP SEC THRU PLATFORM SHOWING CONN TO VESSELS
PLAN AT SECOND CAGE BAND AND ABOVE
SECTION A-A
PLAN AT BOTTOM CAGE ONLY
VIEW B-B
FRONT
SHOWING END POST CONN
ELEVATION
TYP HDRL CONN DETAIL
VIEW SHOWING CONTINUATION OF HANDRAIL AT FULL CIRCLE PLATFORM
TYP SEC THRU CAGE & LADDER AT QUARTER & HALF PLATFORMS

GENERAL NOTES

(1) STRUCTURAL STEEL SHALL CONFORM TO A.I.S.C. SPECIFICATIONS FOR THE DESIGN FABRICATION & ERECTION OF STRUCTURAL STEEL FOR BUILDING
(2) ALL STRUCTURAL STEEL TO BE PAINTED RED LEAD & OIL
(3) FABRICATOR TO FURNISH ALL ERECTION BOLTS REQUIRED PLUS AN EXCESS OF 10% FOR EACH BOLT REQUIRED
(4) FABRICATOR TO FURNISH SHOP DWGS AS REQD BY THE PURCHASE ORDER
(5) FULL CIRCLE PLATFORMS MAY BE BUILT IN TWO TO THREE SECTIONS THEN BOLTED TOGETHER @ ASSY
(6) PROVIDE SAFETY CHAIN AT ALL PLATFORMS
(7) FOR INSUL THK OVER 3" INCREASE LUG PROJECTION BY AMOUNT OVER 3"
(8) SHIP PLATFORM IN MIN ASS'Y NECESSARY FOR FIELD ERECTION
(9) THIS DRAWING IS NOT TO BE USED FOR A SHOP DRAWING
(10) DESIGN CONFORMS TO FEDERAL OCCUPATIONAL SAFETY AND HEALTH ACT

Courtesy of Crest Engineering

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Piping Design Fundamentals
Unit 8

Assignment Sheet 2—Lay Out and Pipe Up a Fractionation Tower and Pumps

Name ______________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Proper preliminary sketches made	_____
Drawing completed from top down with centerline dimensions	_____
Control station and outlet lines properly dilenated	_____
Lettering and general neatness	_____

Directions: Use materials from Assignment Sheet 1 to help you complete this assignment on "C" size vellum using the scale 3/8" = 1'-0". Lay out and pipe up a plan and an elevation view of a fractionation tower and pumps using the following procedure.

CAD Alert: Here is where your CAD workstation can really save you time. Because you saved materials from Assignment Sheet 1, you can retrieve them and have a real headstart on your assignment.

Procedure:

1. Obtain the mechanical flow diagram.

   Note: It is given for this assignment.

2. Refer to plot plan and equipment drawing for equipment and structural steel layout.

   Note: A partial plan is given for this assignment.

3. Review the underground piping and electrical drawings.

   Note: These are not given for this assignment.

4. Draw in lightly the match lines matching another drawing.
5. Locate and draw in centerlines of the fractionation tower and pumps.
6. Letter lightly the coordinates of the equipment.

Assignment Sheet 2

7. Draw in lightly the equipment foundations.

   Note: For this assignment make foundations 1′-0″ larger than equipment.

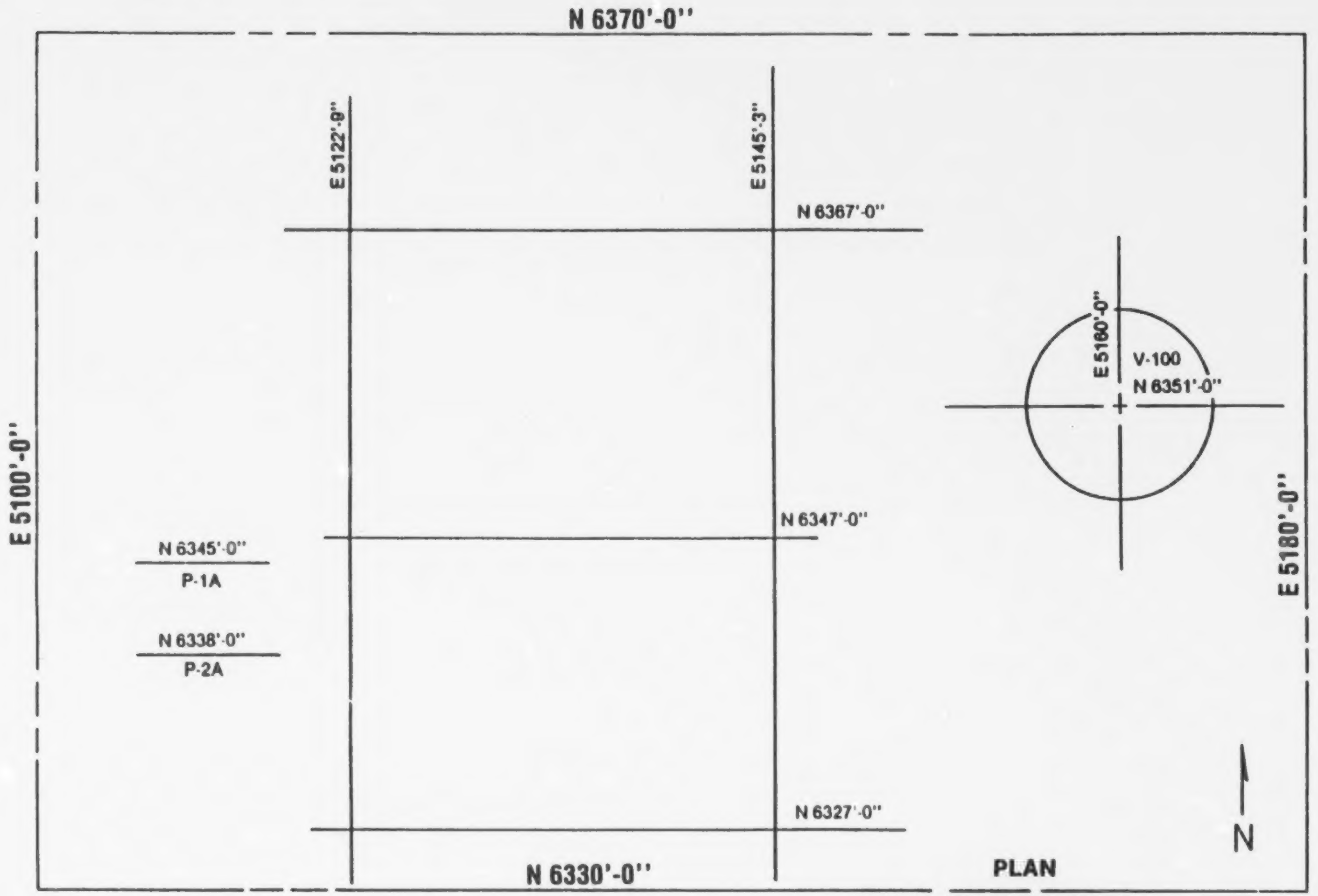
8. Draw and label coordinates of the structural steel pipe racks.
9. Referring to vessel drawing, draw vessel and nozzle orientation.
10. Draw in lightly platform and ladders.
11. Draw suction and outlet connections of pumps.

    Note: Use given pump size.

12. Pipe up 8″ - HCL - 92A - L2 reflux line from tower inlet to pump discharge.
13. Start at the top of the tower and draw down.
14. Connect the reflux nozzle and then go down the tower.
15. Draw all lines down the tower, showing platforms, ladders, and pipe supports.
16. Dimension pipe using centerlines.
17. Start piping up the plan view and check the flow diagram for control station assemblies and meter runs.
18. Locate the control station 2′-0″ out from the centerline of the pipe rack columns.
19. Draw all tower piping down to pipe rack, to pump and outlet lines, and to match lines for this assignment.
20. Continue suction lines to top of pipe rack.
21. Continue line 8″ - HCL - 92 - L2 over the top of pipe rack and down to discharge of pumps.

    Note: Use correct procedure for connecting pumps.

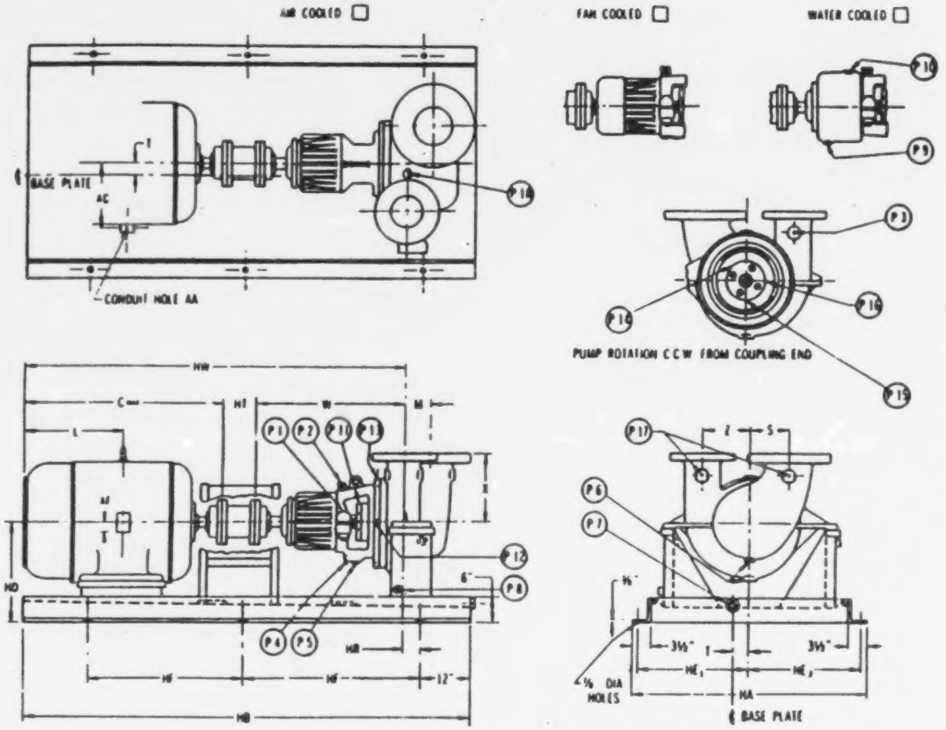
Assignment Sheet 2


N 6370'-0''
E 5122'-9''
E 5145'-3''
N 6367'-0''
E 5180'-0''
V-100
N 6351'-0''
E 5100'-0''
N 6347'-0''
N 6345'-0''
P-1A
N 6338'-0''
P-2A
E 5180'-0''
N
N 6327'-0''
N 6330'-0''

PLAN

TOP OF PUMP FDN 101'-0"
TOP OF FRACT FDN 101'-6"
TOP OF PIPE RACK STEEL 112'-6"

Assignment Sheet 2


AIR COOLED ☐
FAN COOLED ☐
WATER COOLED ☐
BASE PLATE
AC
CONDUIT HOLE AA
P14
P10
P9
P3
P16
P15
PUMP ROTATION C.C.W. FROM COUPLING END
HW
C
HT
W
M
L
P1
P2
P11
P13
P12
P8
P4
P5
HD
HR
HF
12"
6"
HB
P17
P6
P7
Z
S
½"
3½"
HE1
HE2
HA
½ DIA HOLES
℄ BASE PLATE

ITEM	SIZE	DESCRIPTION	YES	NO
P1	4 OZ.	OILER – FAR SIDE	X	
P2		OIL FILLER CUP	X	
P3	½ P.T.	SEAL RECIRCULATION CASE TAP	X	
P4	½ P.T.	OIL DRAIN – PLUGGED	X	
P5	¾ P.T.	DRAIN	X	
P6	¾ P.T.	CASE DRAIN – PLUGGED		
P7	1½ P.T.	BASE PLATE DRAIN	X	
P8	½ P.T.	PED. COOL. WATER IN & OUT		
P9	½ P.T.	INLET BRG. WATER JACKET		
P10	½ P.T.	OUTLET BRG. WATER JACKET		
P11	¼ P.T.	PACKING GLAND QUENCH		
P12	½ P.T.	CAGE RING CONN. IN & OUT ON HORIZ. ℄		[illegible]
P13	SEE NOTE 4	STUFF. BOX WATER JACKET CLOSURE		
P14	½ P.T.	SEAL VENT OR QUENCH INLET		
P15	½ P.T.	SEAL QUENCH DRAIN		
P16	½ P.T.	SEAL INJECTION		
P17	¾ P.T.	CAGE CONNECTION		
P18	¾ P.T.	VENT CONNECTION		

NOTES:

1. PUMPS ARE SELF VENTING
2. SUCT. & DISCH. FLGS. #300 A.S.A. 1/16 R.F.
3. THREE 4" DIA. GROUT HOLES (MIN) ½ DIA. VENT HOLES - 4 CORNERS OF BASE
4. ½ P.T. IN & OUT ON VERT. ℄ ALWAYS SUPPLIED WITH OR WITHOUT WATER JACKET CLOSURE
5. BOSSES PROVIDED FOR ADDITION OF TAPS WHEN REQUIRED
6. BJ STD. COUPLING GUARD MEETS CAL/W. SAFETY REQUIREMENTS

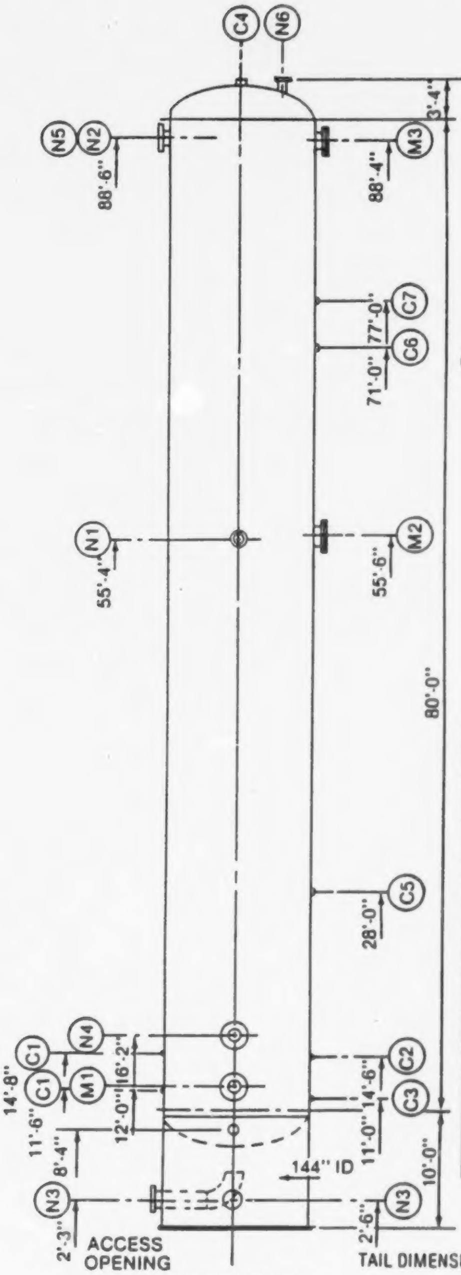
BASEPLATE DIMENSIONS					
BASE NO.	HA	HB	HE1	HE2	HF
S7	53	103	27¾	21¾	39½

↓

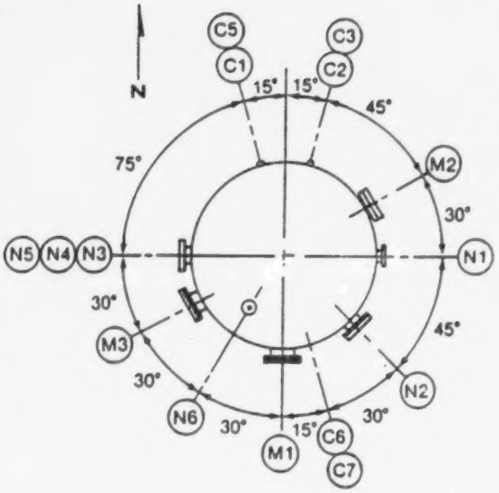
PUMP SIZE				MOTOR FRAME SIZE							326TS			364TS			365TS			405TS			444TS			445TS			447TS			
										C	29 5/8			30 15/16			31 13/16			35 11/16			38 7/8			40 7/8			47 1/4			
Line No.	Dis-charge	Suc-tion	Im-peller	M	S	W	X	Z	HT	HR	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	HD	HW	Base No.	T
→ 17	8	10	16	6	5	28 11/16	16	12 1/8	7	7 1/8	27	65 5/16	S-7	27	66 3/8	S-7	27	67 5/8	S-7	27	71 3/8	S-7	27	74 5/16	S-7	27	76 5/16	S-7	27	82 11/16	S-7	3
19	10	12	18	7	5	28 11/16	20	14 1/4	7	5 1/4	27	65 5/16	S-7	27	66 3/4	S-7	27	67 3/4	S-7	27	71 1/2	S-7	27	74 11/16	S-7	27	76 11/16	S-7	27	83 1/16	S-7	3

Courtesy BWIP International

Assignment Sheet 2


C4
N6
3'-4"
N5
N2
88'-6"
M3
88'-4"
C7
77'-0"
C6
71'-0"
N1
55'-4"
M2
55'-6"
80'-0"
C5
28'-0"
N4
C1
16'-2"
C2
14'-8"
C1
M1
14'-6"
C3
11'-6"
12'-0"
11'-0"
8'-4"
144" ID
10'-0"
N3
N3
2'-3"
ACCESS OPENING
2'-6"

ELEVATION


N
C5
C1
C3
C2
15°
15°
45°
75°
M2
30°
N5
N4
N3
N1
30°
45°
M3
30°
N2
N6
30°
15°
30°
C6
M1
C7

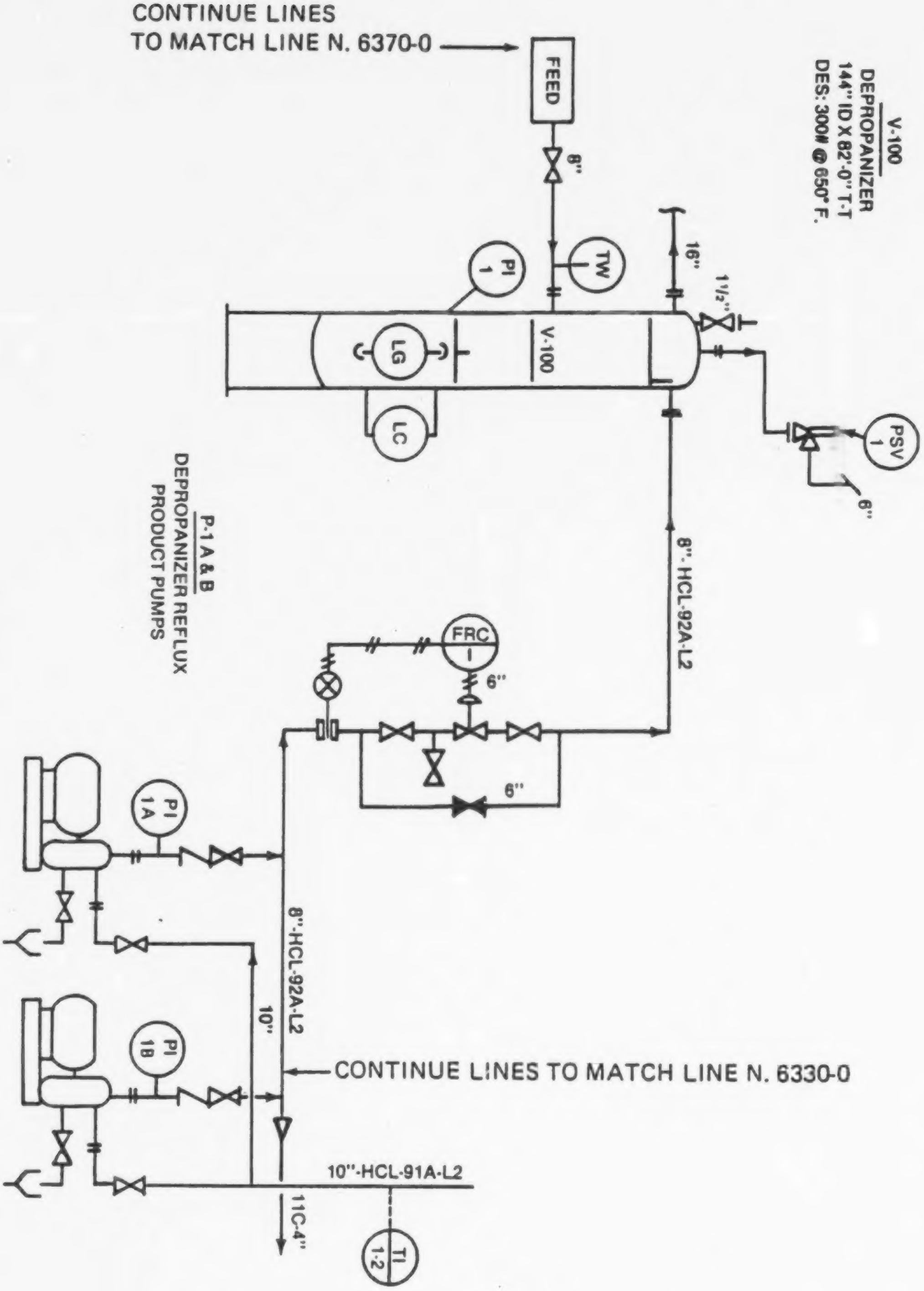
ORIENTATION

MK	NO	SIZE	RATING	FACING	DESCRIPTION
N6	1	6"	300#	RF	PRESS SAFETY VALVE
N5	1	8"			REFLUX INLET
N4	1	20"			REBOILER RETURN OUT
N3	1	18"			BOTTOM OUTLET
N2	1	16"			VAPOR OUTLET
N1	1	8"	300#	RF	FEED INLET
M3	1	18"	300#	RF	MANWAY
M2	1	18"	300#	RF	MANWAY
M1	1	18"	300#	RF	MANWAY
C7	1	1	6000#	CPLG	TEMP RECORDER CONT
C6	1	1	6000#		" " "
C5	1	1	6000#		" " "
C4	1	1	3000#		VENT
C3	1	1 1/2"	3000#		STEAM OUT
C2	1	3/4"	6000#		PRESS. INDICATOR
C1	2	3/4"	6000#	CPLG	LEVEL GAGE

CONNECTION SCHEDULE

TAIL DIMENSIONS ARE TO BOTTOM OF BASE PLATE

Assignment Sheet 2



CONTINUE LINES TO MATCH LINE N. 6370-0

CONTINUE LINES TO MATCH LINE N. 6330-0

FEED
8"
TW
PI 1
16"
1½"
V-100 DEPROPANIZER 144" ID X 82'-0" T-T DES: 300# @ 650° F.
V-100
LG
LC
PSV 1
6"
8"-HCL-92A-L2
FRC 1
6"
6"
P-1 A & B DEPROPANIZER REFLUX PRODUCT PUMPS
PI 1A
PI 1B
10"
8"-HCL-92A-L2
10"-HCL-91A-L2
11C-4"
TI 1-2

Plot Plans and Equipment Layout
Unit 9

Objective Sheet

Unit Objective

After completing this unit, the student should be able to draw a partial plot plan and a complete plot plan. The student should demonstrate these competencies by completing the assignment sheets and by scoring a minimum of 85 percent on the written test.

Specific Objectives

After completing this unit, the student should be able to:

1. Match terms related to plot plans and equipment layout with their correct definitions.
2. Complete statements about information found on an existing contour drawing.
3. Complete statements about characteristics of a finished contour drawing.
4. Complete statements about information found on a plot plan.
5. Complete statements about the purposes of a plot plan.
6. Select true statements about characteristics of an area key index plan.
7. Complete statements about the characteristics of an equipment layout sheet.
8. Complete statements about characteristics of an underground area key index plan.
9. Select true statements about characteristics of a firewater and fire fighting equipment plan.
10. Draw a partial plot plan. (Assignment Sheet 1)
11. Draw a plot plan. (Assignment Sheet 2)

Plot Plans and Equipment Layout
Unit 9

Suggested Activities

Instructional Plan

Preparation

1. Read the unit carefully and plan for instruction or individual learning activities. Study the specific objectives to determine the order in which you will present the objectives.
2. Review Teaching Suggestions section that follows. Plan for classroom activities.
3. Plan enrichment of exceptional students as well as accommodation of special needs students.
4. Make transparencies from transparency masters included with this unit. These appear in the teacher edition only and are designed to be used with the following objectives:

   TM 1—Legal Description (Objective 1)
   TM 2—Plat Drawing (Objective 1)
   TM 3—Contour Drawing (Objective 2)
   TM 4—Existing Contour Drawing (Objective 2)
   TM 5—Finished Contour Drawing (Objective 3)
   TM 6—Plot Plan (Objective 5)
   TM 7—Area Key Index Plan (Objective 6)
   TM 8—Equipment Layout Sheet (Objective 7)
   TM 9—Underground Area Key Index Plan (Objective 8)
   TM 10—Firewater and Fire Fighting Equipment Plan (Objective 9)

5. Develop teaching plan. Adjust for different learning styles.
6. Make copies of Unit Evaluation Form.

Delivery and Application

7. Provide students with unit of instruction.
8. Discuss unit and specific objectives.
9. Discuss information sheet. Implement teaching plan to localize, supplement, and personalize the unit. Reinforce basic academic and workplace skills when applicable.
10. Discuss the assignment sheets. Review criteria for evaluation of these activities.

Suggested Activities

Evaluation

11. Discuss the use of the Unit Evaluation Form with students. Discuss the rating scale that will be used for student evaluation.

12. Make copies of the written test. Add or modify test items as needed.

13. Give written test.

14. Compile assignment sheet ratings and written test scores on the Unit Evaluation Form. Include any additional assignment sheets.

15. Reteach and retest as required.

Teaching Suggestions

Note: Skill areas appearing in boldface type in the Teaching Suggestions refer to the academic and workplace skills identified by the American Society for Training and Development (ASTD) and the U.S. Department of Labor. These have been adapted by MAVCC.

1. Invite the owner of a recently constructed industry in your area to talk to students about local conditions that affect site selection and planning plots and layouts. Encourage your visitor to bring preliminary items and drawings that reflect site selection and development. Skill areas: **Basic skills, listening; Learning skills, learning to learn.**

2. Talk to students about the importance of transportation to an industry, the importance of being close to the source of the raw materials they use, the importance of access roads and the proximity of major highways. Discuss the importance of airport access to certain industries. Encourage students to participate in the discussion and ask students to work in teams to lead the discussion. Skill areas: **Group effectiveness skills, teamwork.**

3. Challenge students to complete the assignment sheets at a CAD workstation. Provide any references they may need to complete the assignments. Skill areas: **Learning skills, learning to learn.**

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Suggested Activities

Resources Used in Developing This Unit

1. Davis, Ronald and Donald White. *Pipe Drafting.* Stillwater, OK: The Mid-America Vocational Curriculum Consortium, 1983.

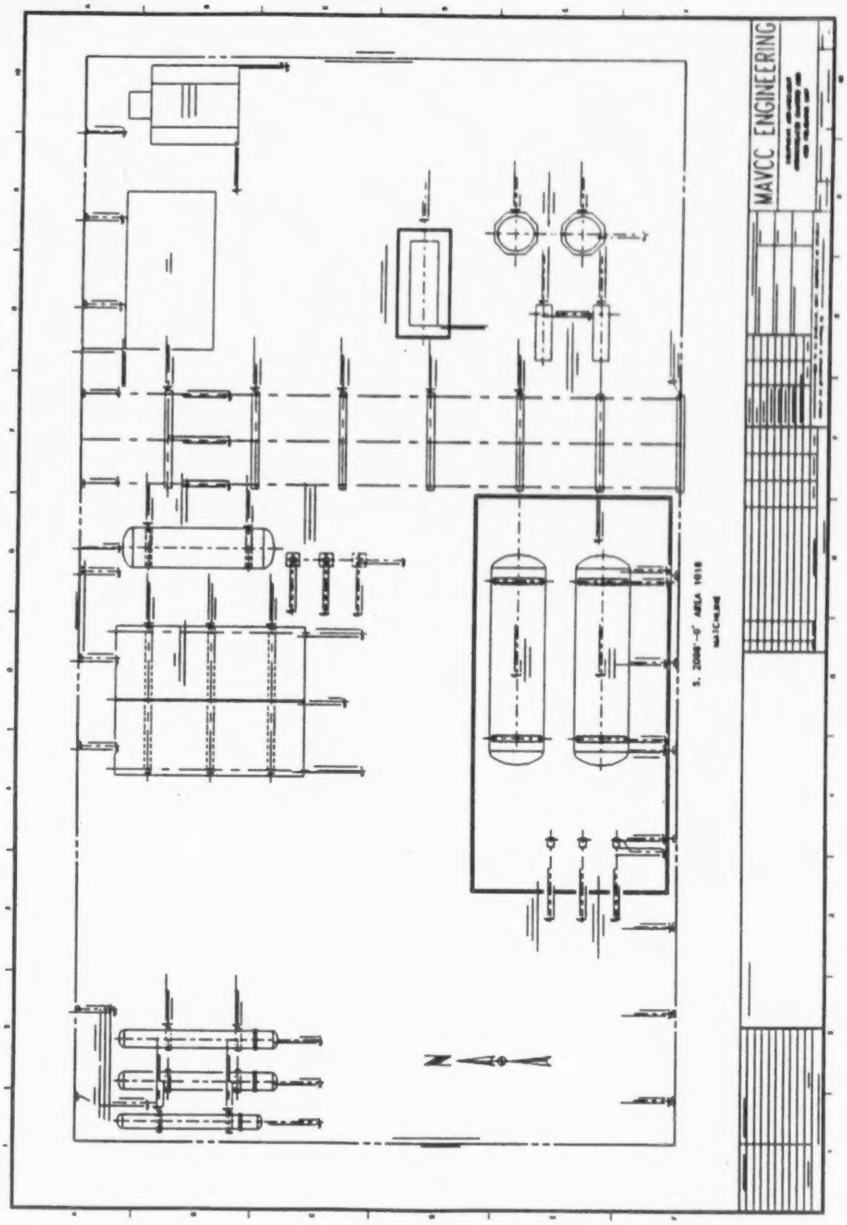
2. Hartman, William and Fred Williams. *Pipe Drafting.* New York: Gregg Division/McGraw-Hill Book Co., 1981.

3. Weaver, Rip. *Process Piping Drafting*, 3rd. ed. Houston, TX: Gulf Publishing Company, 1990.

Plot Plans and Equipment Layout
Unit 9

Answers to Assignment Sheets

Assignment Sheet 1

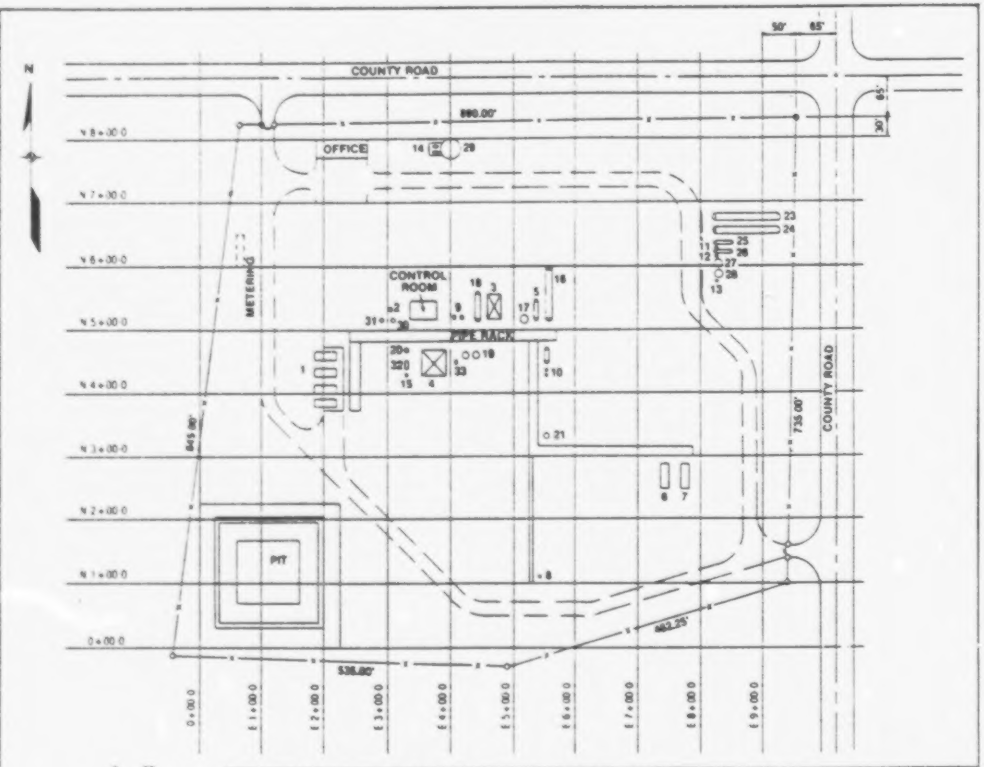

MAVCC ENGINEERING
N

Assignment Sheet 2

Answers to Assignment Sheets

EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER


N
COUNTY ROAD
50'
65'
65'
30'
890.00'
N 8+00.0
N 7+00.0
N 6+00.0
N 5+00.0
N 4+00.0
N 3+00.0
N 2+00.0
N 1+00.0
0+00.0
OFFICE
14
29
METERING
CONTROL ROOM
2
31
30
9
18
3
17
5
16
23
24
11
12
25
26
27
28
13
PIPE RACK
1
20
32
15
4
33
19
10
21
6
7
8
PIT
845.00'
735.00'
COUNTY ROAD
682.25'
535.00'
0+00.0
E 1+00.0
E 2+00.0
E 3+00.0
E 4+00.0
E 5+00.0
E 6+00.0
E 7+00.0
E 8+00.0
E 9+00.0
0
50
SCALE

NO	REVISION	BY	DATE	APPR	REFERENCE DRAWINGS

MAVCC ENG. CO.

PLOT PLAN

BY D. White | DATE 1-14-94 | PL-2-0

Pipe Drafting With CAD, Unit 9
Teacher Page 6

Plot Plans and Equipment Layout
Unit 9

Answers to Written Test

1. a. 3
   b. 6
   c. 10
   d. 12
   e. 5
   f. 15
   g. 13
   h. 8
   i. 7
   j. 4
   k. 1
   l. 14
   m. 11
   n. 9
   o. 2

2. a. Scale
   b. Sea level

3. a. New
   b. The company's civil department
   c. Major

4. a. Equipment legend
   b. Existing roads
   c. Coordinates
   d. Equipment locations
   e. Building locations

5. a. General
   b. And
   c. Single line
   d. Interested parties

6. d, e

7. a. Equipment descriptions
   b. Coordinates

8. a. Plot
   b. Benchmark
   c. When all

9. a, b, c, e, f

Plot Plans and Equipment Layout
Unit 9

Written Test

Name ______________________________ Date ______________ Score _____

1. Match the terms on the right with the correct definitions.

_____a. A plot plan drawing having match lines and coordinates showing what aboveground areas in a plant need to be drawn

_____b. Point of known elevation and coordinates serving as reference

_____c. Lines which connect points having the same elevation to indicate slope and shape of land

_____d. A method of dimensioning which uses a grid and N/S or E/W dimensions from a benchmark

_____e. Vertical distance above or below sea level

_____f. Uniformly spaced horizontal and perpendicular lines

_____g. Where a general area of land is located

_____h. The minimum amount of earth needed to cover pipe or equipment

_____i. Map of a given tract of land or subdivision

_____j. A drawing showing outlines of all main items on a site

_____k. A specific area of land where an actual or planned structure is to be built

1. Site
2. Underground area key index plan
3. Area key index plan
4. Plot plan
5. Elevation
6. Benchmark
7. Plat
8. Minimum cover
9. Topography
10. Contour lines
11. Surveyor
12. Coordinate system
13. Locality
14. Soil bearing test
15. Grid

Written Test

_______l. A test to determine how much pressure the soil in a specific area will withstand

_______m. Someone, usually state licensed, who determines and delineates the form, extent, and position of an area of land

_______n. Graphic delineations in detail of natural and man-made features of an area to show relative positions and elevations

_______o. A plot plan drawing having match lines and coordinates showing what underground areas in a plant need to be drawn

2. Complete statements about information found on an existing contour drawing. Circle the material that best completes each of the following statements.

   a. A contour drawing should indicate its (**date**) (**scale**), boundary lines, and boundary directions and lengths.

   b. A contour drawing will also include a benchmark, a north arrow, and contour line elevations in relationship to (**sea level**) (**surrounding landmarks**), if the information is known.

3. Complete statements about characteristics of a finished contour drawing. Circle the material that best completes each of the following statements.

   a. A finished contour drawing shows (**new**) (**existing**) contour line elevations.

   b. The finished contour drawing is drawn after the plot plan is approved, and is usually drawn by (**the company's civil department**) (**a local drafting firm**).

   c. The major contribution of the finished contour drawing is that it helps determine the amount of (**major**) (**below grade**) dirt work that needs to be done in the plant and on site.

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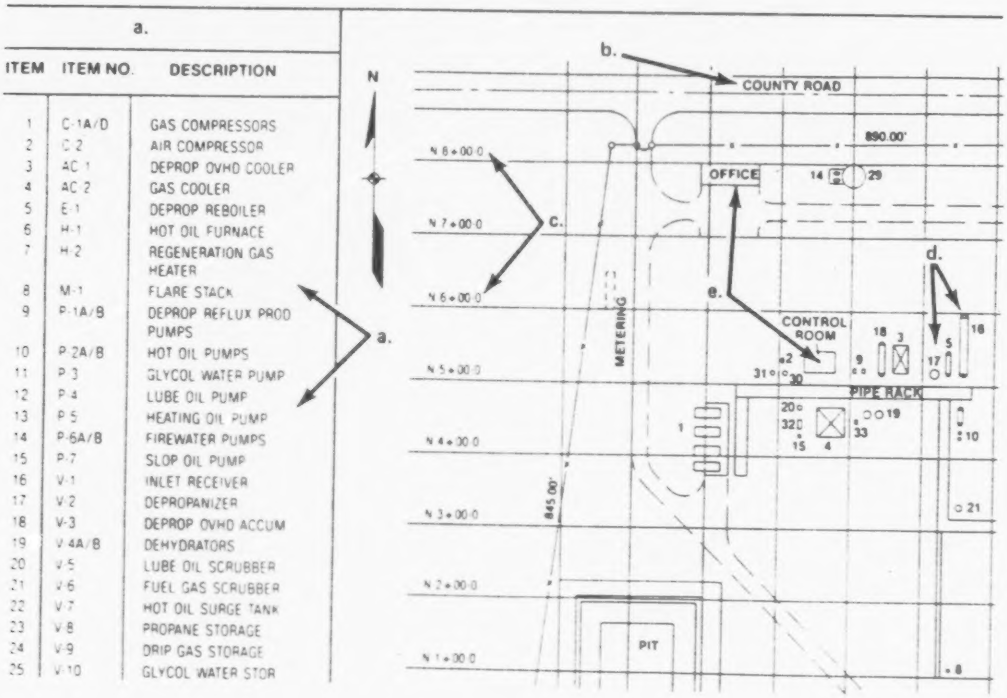
Written Test

4. Identify selected information on the following plot plan. Write the correct identification in the blanks provided.



a.

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR

a.
b.
c.
d.
e.
N
COUNTY ROAD
890.00'
N 8+00.0
N 7+00.0
N 6+00.0
N 5+00.0
N 4+00.0
N 3+00.0
N 2+00.0
N 1+00.0
OFFICE
14
29
METERING
CONTROL ROOM
18
3
16
5
17
2
31
30
9
PIPE RACK
20
32
15
4
19
33
1
10
845.00'
21
PIT
8

a. ____________________ b. ____________________

c. ____________________ d. ____________________

e. ____________________

Written Test

5. Complete statements about the purposes of a plot plan. Circle the information that best completes each of the following statements.

   a. A plot plan shows the (**specific**) (**general**) arrangement of a plant and can be used with an existing contour drawing to develop the finished graded contour drawing.

   b. A plot plan is used to make an area key index plan (**and**) (**but not**) an underground area key index plan.

   c. A plot plan is used to make all of the system layout plans including (**single line**) (**double line**) pipe layout drawings of major lines and equipment.

   d. Generally, the plot plan is used for locating equipment in a plant and for communicating information about the plant to (**interested parties**) (**engineers and manufacturers**).

6. Select true statements about characteristics of an area key index plan. Place an "X" beside each true statement.

   ______a. An area key index plan is a sepia of an elevation view with a grid or match lines added to the sepia to divide the area into blocks.

   ______b. The blocks on an area key index plan should be no larger than 200′ × 150′ so that the area can be drawn on a "D" size sheet of drawing paper.

   ______c. Each grid line has a coordinate number determined from elevation.

   ______d. Each coordinate line number includes direction, number of hundred feet, number of feet, and number of inches.

   ______e. Each area that needs a detailed drawing made of it will have an X in the block to indicate the need for a piping plan, and each piping plan will have a drawing number that references the key area index plan.

7. Complete statements about characteristics of an equipment layout sheet. Circle the material that best completes each of the following statements.

   a. An equipment layout sheet should have a legend with item numbers and (**reference marks**) (**equipment descriptions**).

   b. A layout sheet is used to determine equipment (**placement**) (**coordinates**).

Written Test

8. Complete statements about characteristics of an underground area key index plan. Circle the material that best completes each of the following statements.

   a. An underground area key index is a layer on the (**plot**) (**elevation**) plan with a grid added to the sepia to divide the area into blocks called underground piping plans.

   b. Each grid line has a coordinate number determined from the (**contour drawing**) (**benchmark**), and each block has a drawing number.

   c. Underground piping plans can be drawn only (**if most**) (**when all**) piping plans are completed for the underground piping area.

9. Select true statements about characteristics of a firewater and fire fighting equipment plan. Place an "X" beside each true statement.

   _______a. A fire fighting equipment plan is a layer on the plot plan which shows the routing of firewater lines with coordinates.

   _______b. The fire fighting plan shows the location of all fire hydrants with coordinates E and W and N and S, and the location of all fire hydrants with monitors and spray radiuses with coordinates E and W and N and S.

   _______c. The fire fighting plan shows the location of all fire valves, all line numbers, and line sizes, and includes all line reducers.

   _______d. The fire fighting plan includes the minimum cover along with a detailed plan view of a fire hydrant with a guard post, which is a small steel building used to house hydrant controls.

   _______e. The fire fighting plan also shows a detailed elevation view of a fire hydrant, and has a legend describing all new equipment or lines placed on the drawing.

   _______f. The fire fighting plan shows all fire fighting equipment on the drawing located with a referencing symbol which relates to the table.

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*Permission to duplicate this test is granted.

Plot Plans and Equipment Layout
Unit 9

Unit Evaluation Form

Student Name ______________________ Unit Rating ________

Assignment Sheet 1—Draw a Partial Plot Plan Rating ______

Comments: ________________________________

____

Assignment Sheet 2—Draw a Plot Plan Rating ______

Comments: ________________________________

____

Written Test Scores

Pretest ______ Posttest ______ Other ______

Other ________________________________

____

Teacher Signature ______________________ Date ________

Student Signature ______________________ Date ________

*Permission to duplicate this form is granted.

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Legal Description

STATE OF ARKANSAS
COUNTY OF PAYNE

THIS IS TO CERTIFY: that we have made a careful examination of all record of the offices of the Clerks of the County and District Courts of this County and find as follows:

A good and sufficient legal description of the property is: All that certain real property situated in Payne County, Arkansas described as follows, to wit:

A certain tract of land containing 17.30 acres out of the Dan Fulkerson one-hundred and fifty-eight (158) acre tract; the said 17.30 acres being more particularly described as follows:

① Commencing at a point common to Section 5, 6, 7, and 8 T. 117 N, R. 64 W, proceeding southerly along section line common to aforesaid Section 7 and 8 a distance of 65.00 ft., thence westerly, parallel to section line common to aforesaid 6 and 7 a distance of 65.00 ft. to the point of beginning, being a brass hub bench mark located at the N.E. corner of the Mary Kellum property being 17.30 acres more or less;

② Thence S. 89° 14'W a distance of 890.00 ft. to an iron pipe considered to be the N.W. corner of said 17.30 acres;

③ Thence S 7° 21'W a distance of 845.00 ft. to a marked wooden stake believed to be the original marker placed for the S.W. corner of the aforesaid property;

④ Thence S. 87° 55'E a distance of 535.00 ft. to an iron pipe;

⑤ Thence N. 73° 44'E a distance of 462.25 ft. to an iron pipe on the east line of the aforesaid M. K. property;

⑥ Thence N. 1° 05' E a distance of 735.00 ft. along the east side of the property to the original point of beginning.

We find the record title in:

MARY KELLUM

who acquired the above described land by deed from Dan Fulkerson to Mary Kellum, dated April 15, 1979, recorded in Volume 5555, page 423, of the Deed Records of said County.

Tax Assessor's Records show present owner's address to be:

Mary Kellum
Rt. 1
Hallet, Arkansas

This property is subject to the following outstanding liens:

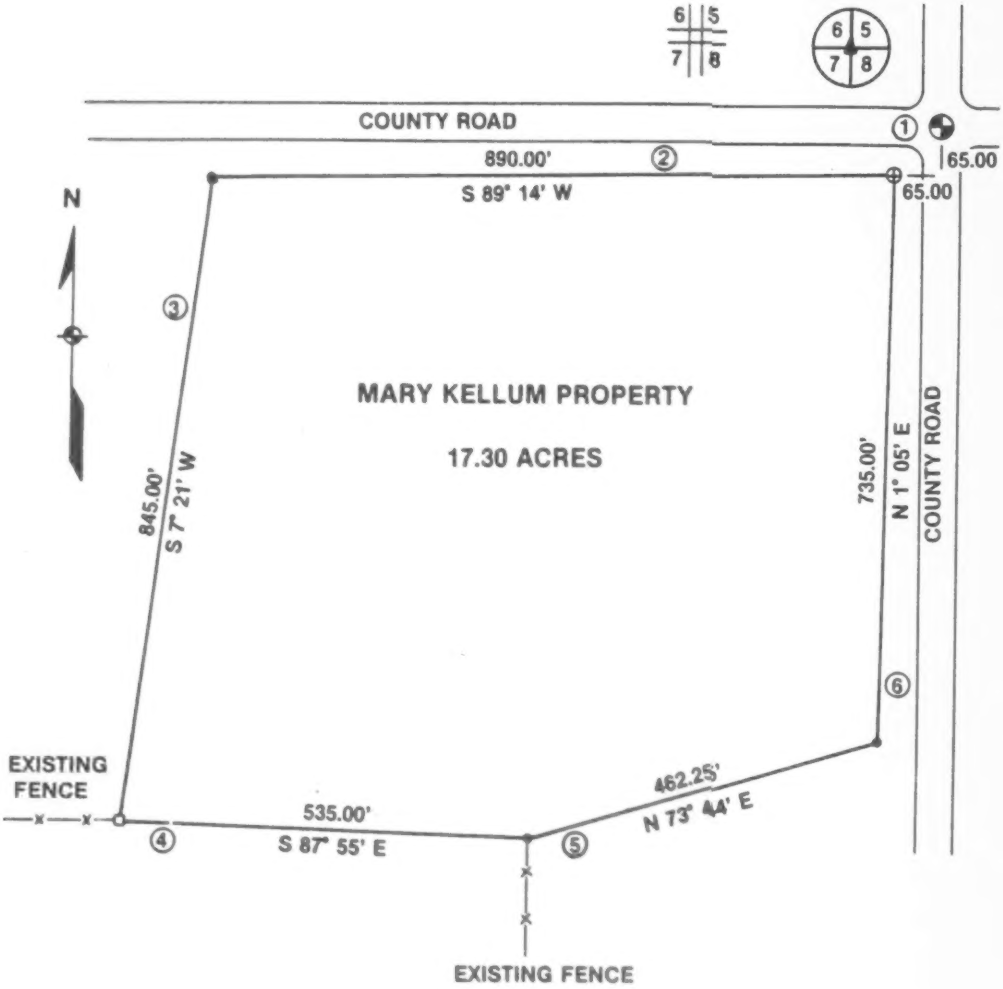
NONE

Examination of Abstracts of Judgements and Federal Tax Liens has been made as to the following names only:

NONE

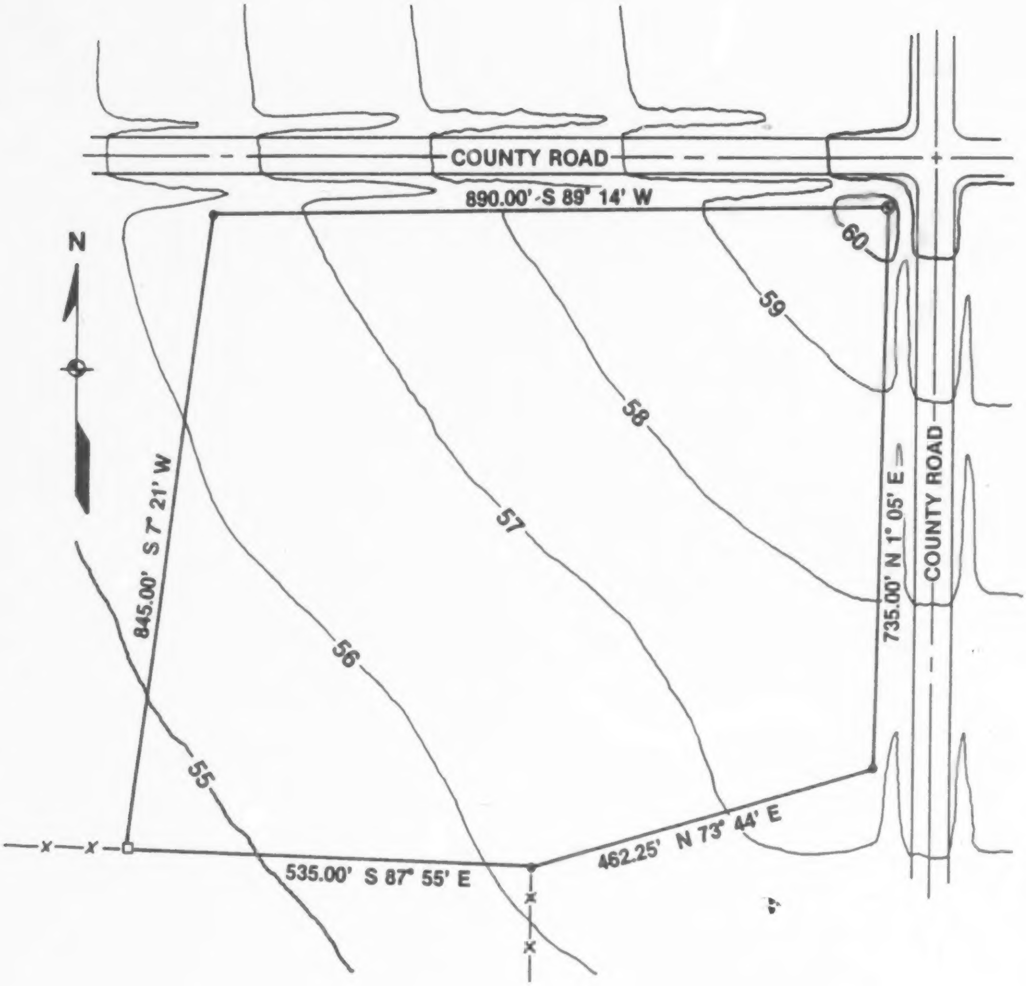
(NOTE: Legal descriptions vary from state to state.)

Plat Drawing

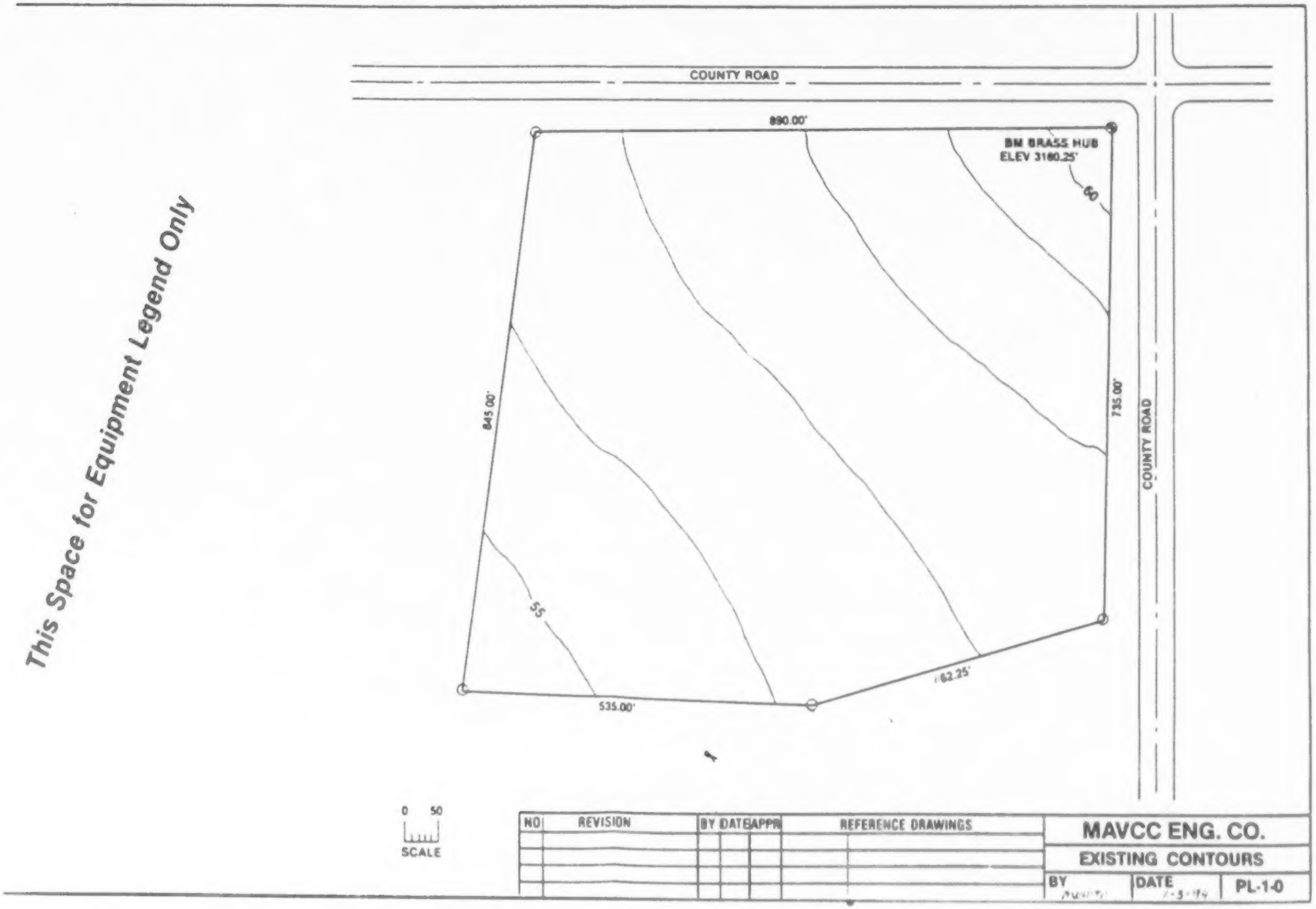

6 5 7 8
6 5 7 8
COUNTY ROAD
①
890.00'
②
S 89° 14' W
65.00
65.00
N
③
MARY KELLUM PROPERTY
17.30 ACRES
845.00'
S 7° 21' W
735.00'
N 1° 05' E
COUNTY ROAD
⑥
EXISTING FENCE
462.25'
N 73° 44' E
535.00'
④
S 87° 55' E
⑤
EXISTING FENCE

• = IRON PIPE
□ = WOODEN STAKE
⊕ = BENCHMARK
◕ = SECTION CORNER

Contour Drawing


COUNTY ROAD
890.00'-S 89° 14' W
60
59
58
57
56
55
N
845.00' S 7° 21' W
735.00' N 1° 05' E
COUNTY ROAD
535.00' S 87° 55' E
462.25' N 73° 44' E

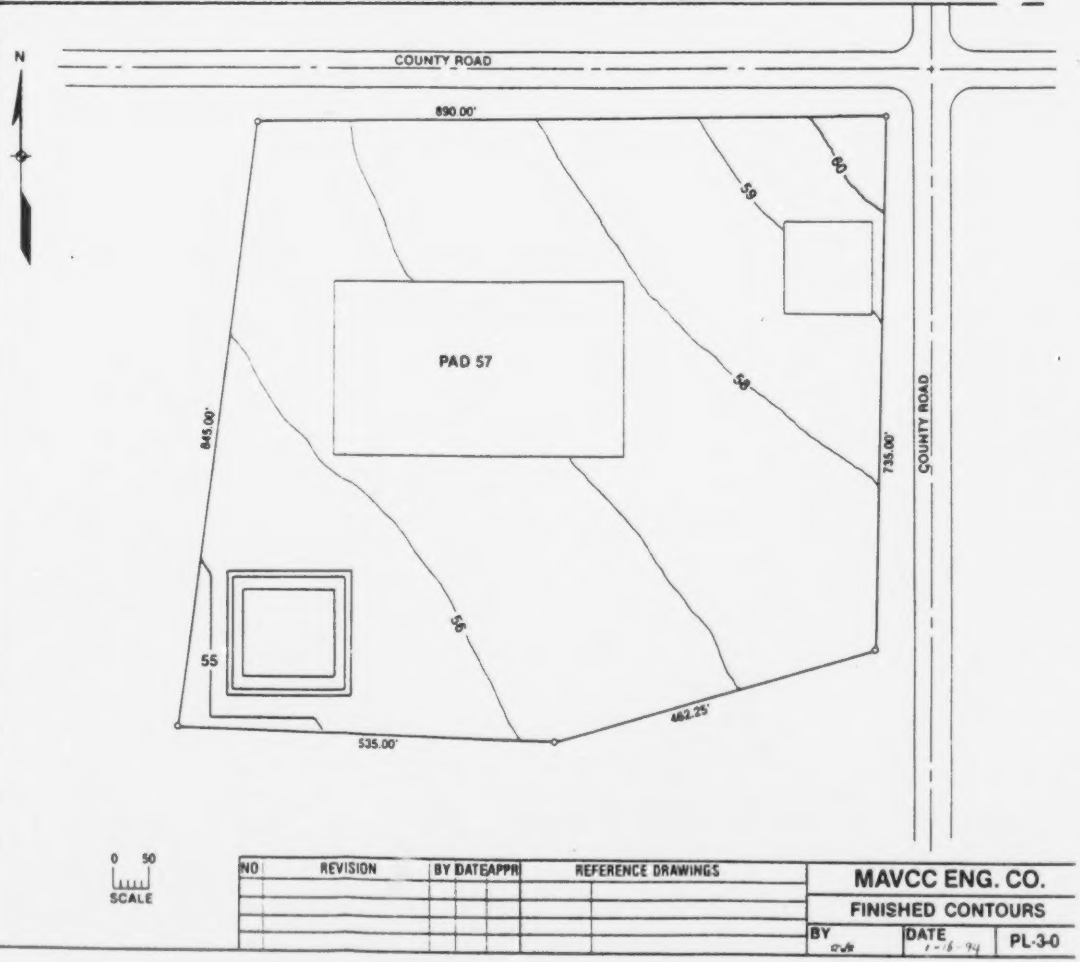
Existing Contour Drawing


This Space for Equipment Legend Only
COUNTY ROAD
890.00'
BM BRASS HUB
ELEV 3160.25'
60
845.00'
735.00'
COUNTY ROAD
55
535.00'
762.25'
0 50
SCALE
NO
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
EXISTING CONTOURS
BY
DATE
PL-1-0

Finished Contour Drawing

EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP. OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP. REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP. REFLUX PROD. PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER


N
COUNTY ROAD
890.00'
60
59
PAD 57
58
845.00'
735.00'
COUNTY ROAD
56
55
462.25'
535.00'
0 50
SCALE
NO
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
FINISHED CONTOURS
BY
DATE 1-16-94
PL-3-0

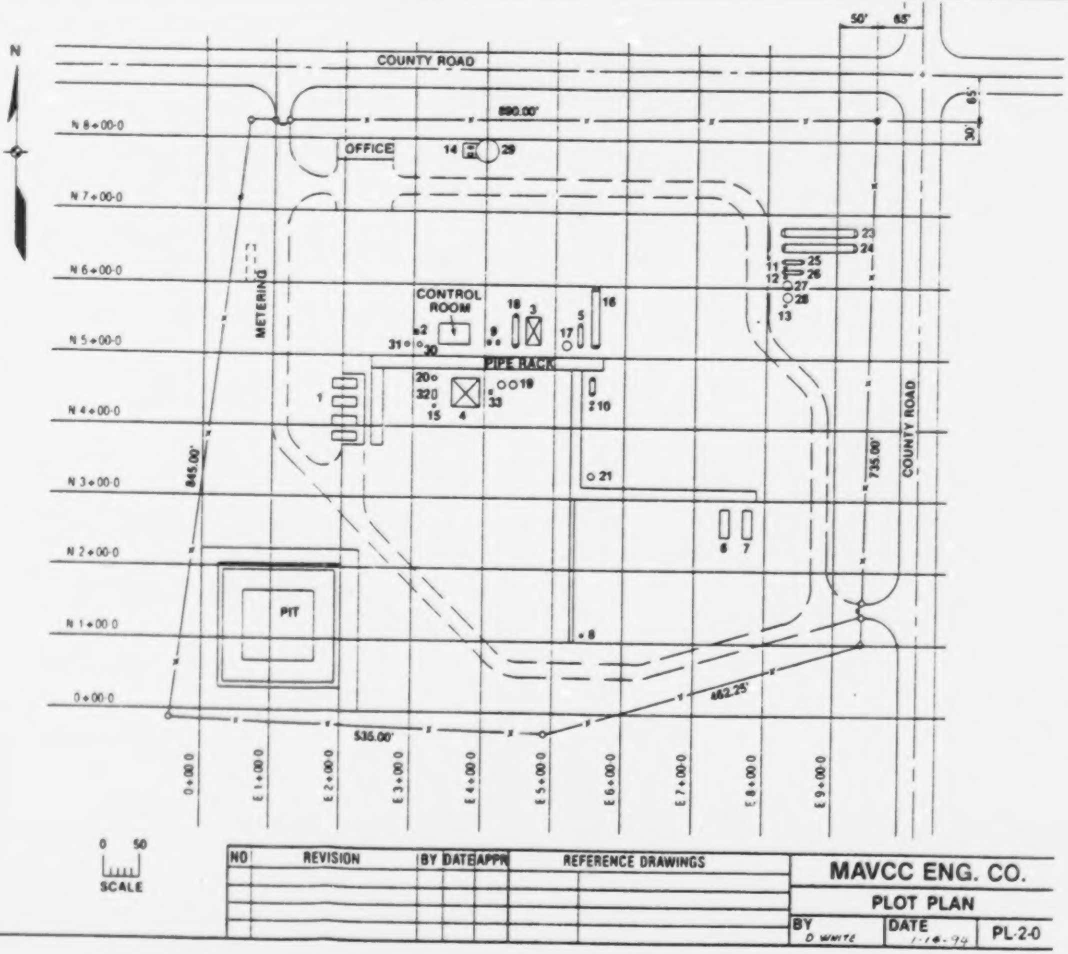
Pipe Drafting With CAD, Unit 9
Teacher Page 25

TM 5

Plot Plan

EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER


N
COUNTY ROAD
50'
65'
65'
30'
890.00'
N 8+00-0
N 7+00-0
N 6+00-0
N 5+00-0
N 4+00-0
N 3+00-0
N 2+00-0
N 1+00-0
0+00-0
OFFICE
14
29
METERING
CONTROL ROOM
2
31
30
9
18
3
17
5
16
PIPE RACK
1
20
32
15
4
33
19
10
21
23
24
25
26
11
12
27
28
13
6
7
PIT
8
845.00'
735.00'
COUNTY ROAD
535.00'
462.25'
0+00-0
E 1+00-0
E 2+00-0
E 3+00-0
E 4+00-0
E 5+00-0
E 6+00-0
E 7+00-0
E 8+00-0
E 9+00-0
0
50
SCALE

NO	REVISION	BY	DATE	APPR	REFERENCE DRAWINGS

MAVCC ENG. CO.

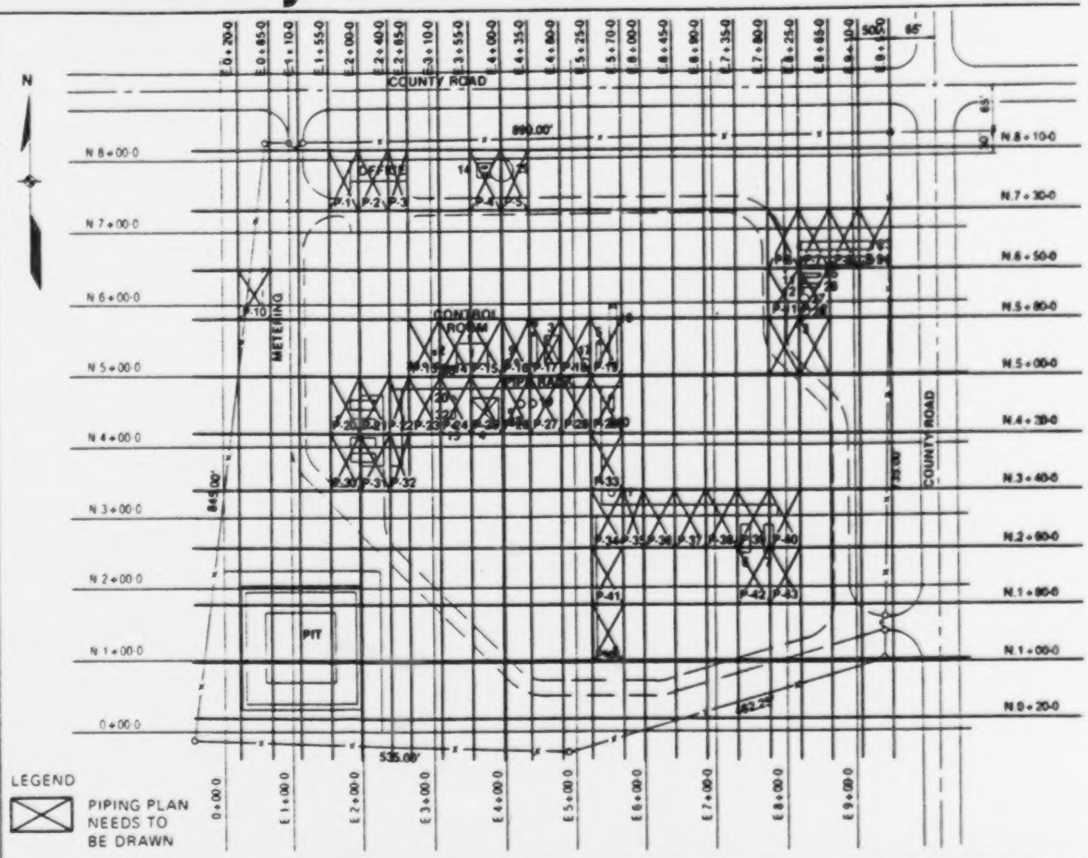
PLOT PLAN

BY D WHITE | DATE 1-14-94 | PL-2-0

BEST COPY AVAILABLE

Area Key Index Plan

EQUIPMENT LEGEND		
ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER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COUNTY ROAD
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N 8+00-0
N 7+00-0
N 6+00-0
N 5+00-0
N 4+00-0
N 3+00-0
N 2+00-0
N 1+00-0
0+00-0
N 8+10-0
N 7+30-0
N 6+50-0
N 5+80-0
N 5+00-0
N 4+30-0
N 3+40-0
N 2+60-0
N 1+80-0
N 1+00-0
N 0+20-0
METERING
CONTROL ROOM
PIPE RACK
PIT
COUNTY ROAD
845.00'
535.00'
462.25'
0+00-0
E 1+00-0
E 2+00-0
E 3+00-0
E 4+00-0
E 5+00-0
E 6+00-0
E 7+00-0
E 8+00-0
E 9+00-0
LEGEND
PIPING PLAN NEEDS TO BE DRAWN
0
50
SCALE

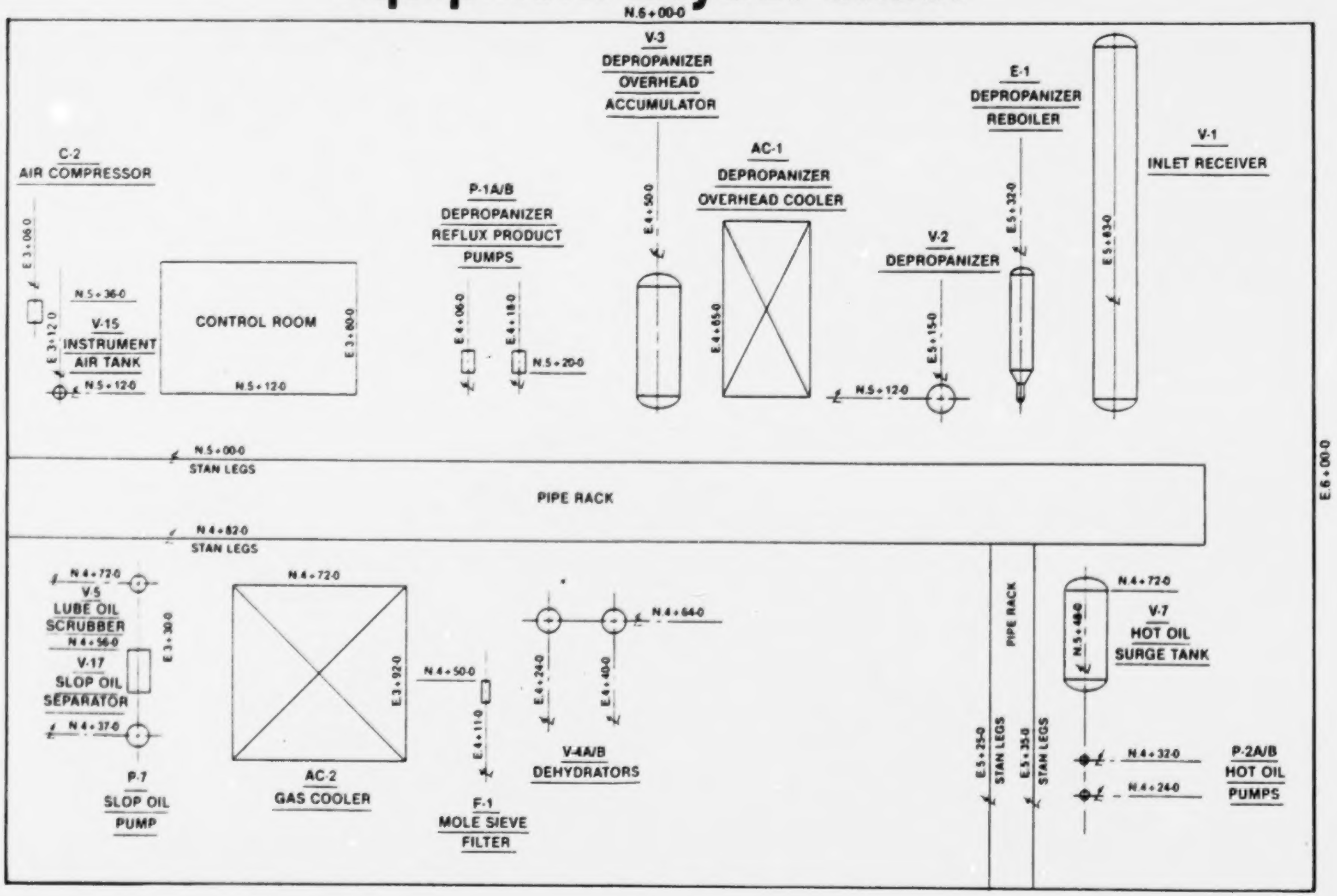
NO	REVISION	BY	DATE	APPR	REFERENCE DRAWINGS	

MAVCC ENG. CO.

AREA KEY INDEX PLAN

BY	DATE	
D white	1-30-93	PL-4-0

Equipment Layout Sheet


N.6+00-0
V-3
DEPROPANIZER
OVERHEAD
ACCUMULATOR
E-1
DEPROPANIZER
REBOILER
V-1
INLET RECEIVER
C-2
AIR COMPRESSOR
AC-1
DEPROPANIZER
OVERHEAD COOLER
P-1A/B
DEPROPANIZER
REFLUX PRODUCT
PUMPS
V-2
DEPROPANIZER
E.3+06-0
N.5+36-0
V-15
INSTRUMENT
AIR TANK
E.3+12-0
N.5+12-0
CONTROL ROOM
E.3+60-0
N.5+12-0
E.4+06-0
E.4+18-0
N.5+20-0
E.4+50-0
E.4+65-0
N.5+12-0
E.5+15-0
E.5+32-0
E.5+63-0
N.5+00-0
STAN LEGS
PIPE RACK
N.4+82-0
STAN LEGS
E.6+00-0
N.4+72-0
V-5
LUBE OIL
SCRUBBER
N.4+56-0
V-17
SLOP OIL
SEPARATOR
N.4+37-0
E.3+30-0
P-7
SLOP OIL
PUMP
N.4+72-0
E.3+92-0
AC-2
GAS COOLER
N.4+50-0
E.4+11-0
F-1
MOLE SIEVE
FILTER
N.4+64-0
E.4+24-0
E.4+40-0
V-4A/B
DEHYDRATORS
PIPE RACK
E.5+25-0
STAN LEGS
E.5+35-0
STAN LEGS
N.4+72-0
N.5+48-0
V-7
HOT OIL
SURGE TANK
N.4+32-0
N.4+24-0
P-2A/B
HOT OIL
PUMPS

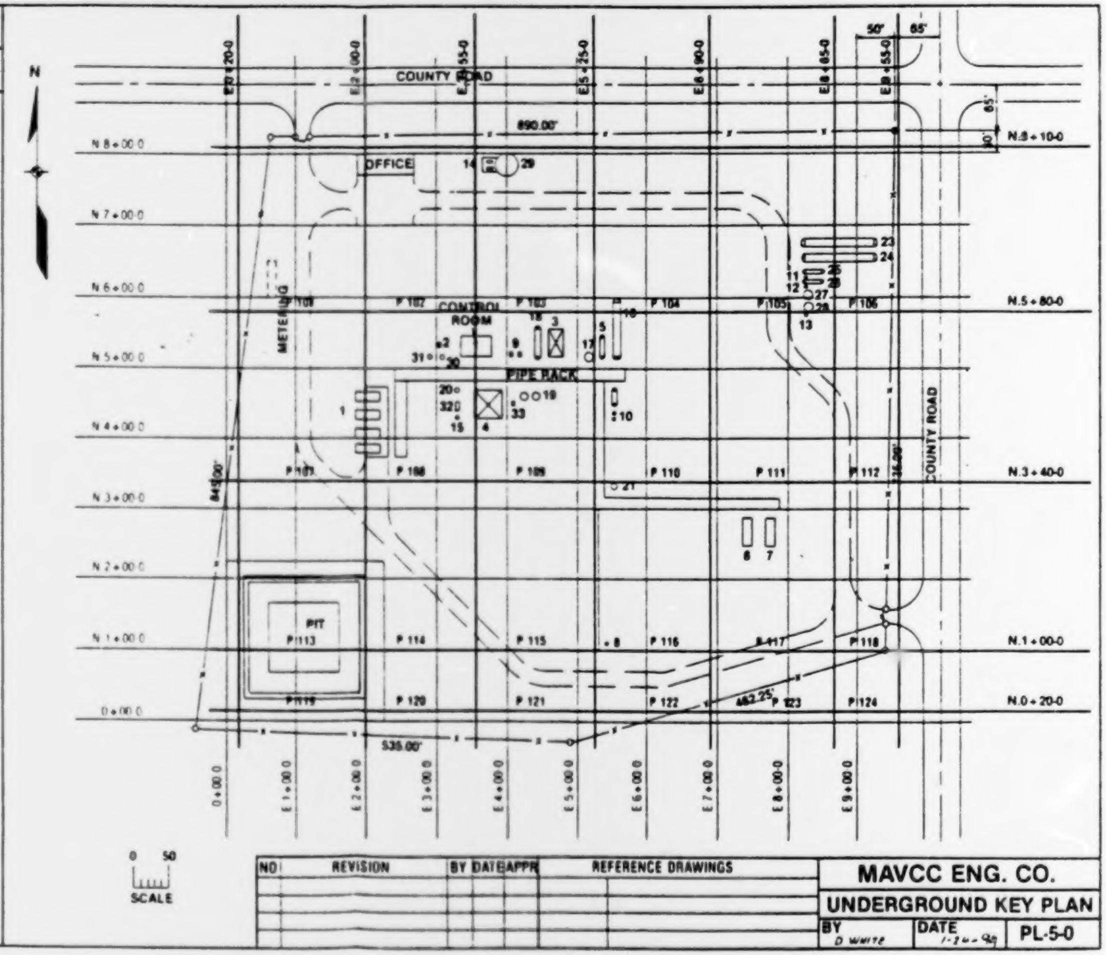
Pipe Drafting With CAD, Unit 9
Teacher Page 31

TM 8

Underground Area Key Index Plan

EQUIPMENT LEGEND

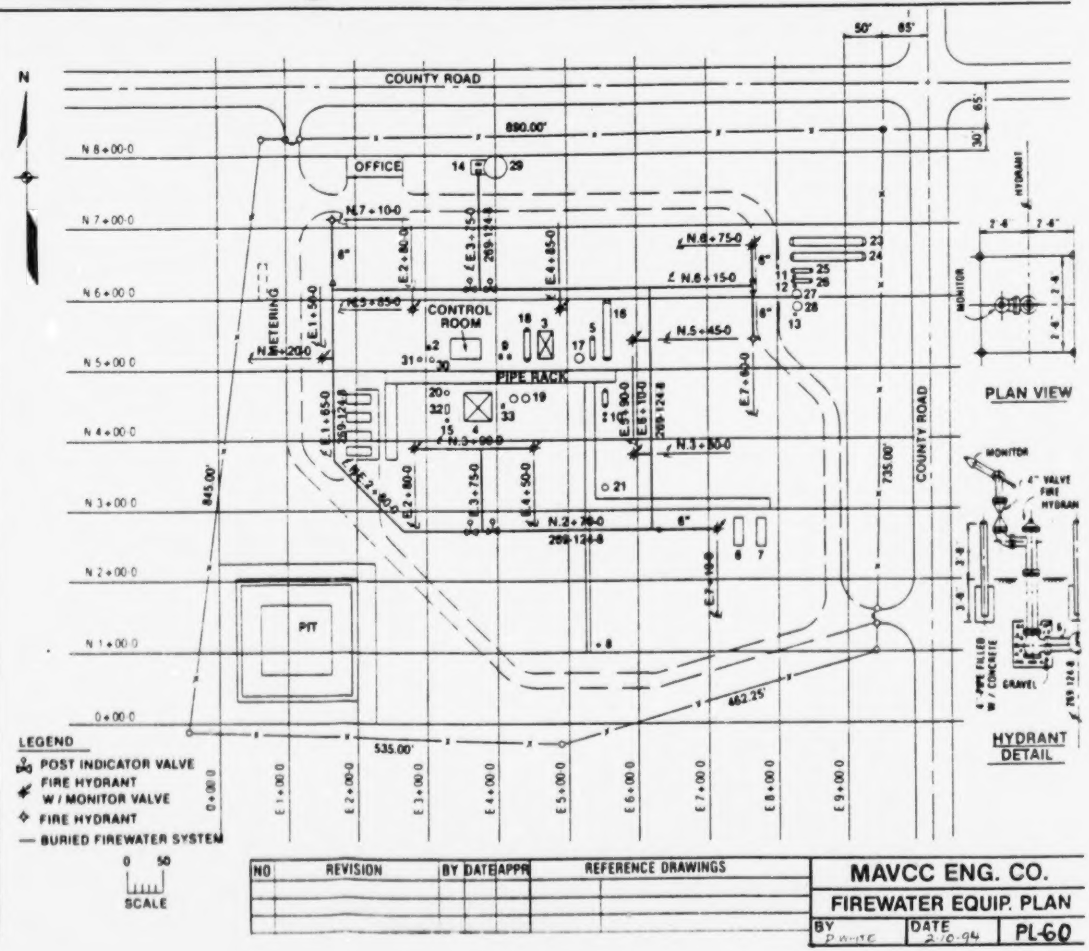
ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER


N
COUNTY ROAD
890.00'
N 8+00 0
N.8+10-0
OFFICE
N 7+00 0
N 6+00 0
N.5+80-0
METERING
CONTROL ROOM
PIPE RACK
N 5+00 0
N 4+00 0
N.3+40-0
N 3+00 0
845.00'
N 2+00 0
PIT
N 1+00 0
N.1+00-0
0+00 0
N.0+20-0
535.00'
482.25'
50'
65'
COUNTY ROAD
E 0+20-0
E 2+90-0
E 3+55-0
E 5+25-0
E 6+90-0
E 8+65-0
E 9+55-0
0+00 0
E 1+00 0
E 2+00 0
E 3+00 0
E 4+00 0
E 5+00 0
E 6+00 0
E 7+00 0
E 8+00 0
E 9+00 0
P 101
P 102
P 103
P 104
P 105
P 106
P 107
P 108
P 109
P 110
P 111
P 112
P 113
P 114
P 115
P 116
P 117
P 118
P 119
P 120
P 121
P 122
P 123
P 124
0 50
SCALE
NO
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
UNDERGROUND KEY PLAN
BY D WHITE
DATE 1-24-9?
PL-5-0

Firewater and Fire Fighting Equipment Plan

EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER


N
COUNTY ROAD
890.00'
50'
65'
30'
OFFICE
CONTROL ROOM
PIPE RACK
METERING
PIT
N.7+10-0
N.6+75-0
N.6+15-0
N.5+85-0
N.5+45-0
N.5+20-0
N.3+90-0
N.3+50-0
N.2+70-0
NE.2+80-0
E.1+50-0
E.1+65-0
E.2+80-0
E.3+75-0
E.4+50-0
E.4+85-0
E.7+60-0
E.7+10-0
269-124-8
6"
845.00'
735.00'
535.00'
462.25'
N 8+00-0
N 7+00-0
N 6+00-0
N 5+00-0
N 4+00-0
N 3+00-0
N 2+00-0
N 1+00-0
0+00-0
0+00-0
E 1+00-0
E 2+00-0
E 3+00-0
E 4+00-0
E 5+00-0
E 6+00-0
E 7+00-0
E 8+00-0
E 9+00-0
LEGEND
POST INDICATOR VALVE
FIRE HYDRANT W / MONITOR VALVE
FIRE HYDRANT
BURIED FIREWATER SYSTEM
0
50
SCALE
HYDRANT
MONITOR
2'-4"
2'-4"
PLAN VIEW
MONITOR
4" VALVE
FIRE HYDRANT
3'-0
3'-0
4" PIPE FILLED W / CONCRETE
GRAVEL
269-124-8
HYDRANT DETAIL
NO
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
FIREWATER EQUIP. PLAN
BY
D WHITE
DATE
2-10-94
PL-60

Plot Plans and Equipment Layout
Unit 9

Information Sheet

1. **Terms and definitions**

    a. **Area key index plan** — A plot plan drawing having match lines and coordinates showing what above-ground areas in a plant need to be drawn

    b. **Benchmark** — Point of known elevation and coordinates serving as reference

    c. **Contour lines** — Lines which connect points having the same elevation to indicate slope and shape of land

    d. **Coordinate system** — A method of dimensioning which uses a grid and N/S or E/W dimensions from a benchmark

    e. **Elevation** — Vertical distance above or below sea level

    f. **Grid** — Uniformly spaced horizontal and perpendicular lines

    g. **Locality** — Where a general area of land is located

    h. **Minimum cover** — The minimum amount of earth needed to cover pipe or equipment

    i. **Plat** — Map of a given tract of land or subdivision

    j. **Plot plan** — A drawing showing outlines of all main items on a site

    k. **Site** — A specific area of land where an actual or planned structure is to be built

    l. **Soil bearing test** — A test to determine how much pressure the soil in a specific area will withstand

    m. **Surveyor** — Someone, usually state licensed, who determines and delineates the form, extent, and position of an area of land

    n. **Topography** — Graphic delineations in detail of natural and man-made features of an area to show relative positions and elevations

    o. **Underground area key index plan** — A plot plan drawing having match lines and coordinates showing what underground areas in a plant need to be drawn

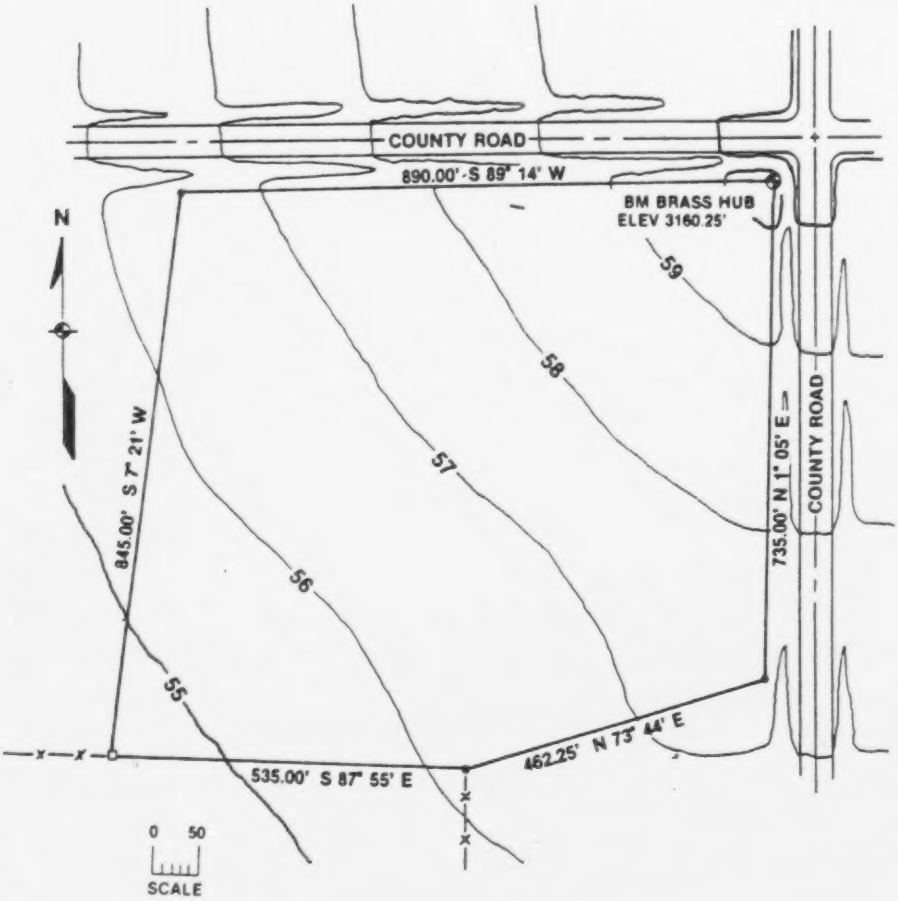
Information Sheet

2. Information found on an existing contour drawing

a. A contour drawing should indicate its scale, boundary lines, and boundary directions and lengths.

b. A contour drawing will also include a benchmark, a north arrow, and contour line elevations in relationship to sea level, if the information is known.

Existing Contour Drawing


COUNTY ROAD
890.00' - S 89° 14' W
BM BRASS HUB
ELEV 3160.25'
N
59
58
57
56
55
845.00' S 7° 21' W
735.00' N 1° 05' E
COUNTY ROAD
462.25' N 73° 44' E
535.00' S 87° 55' E
0 50
SCALE

Information Sheet

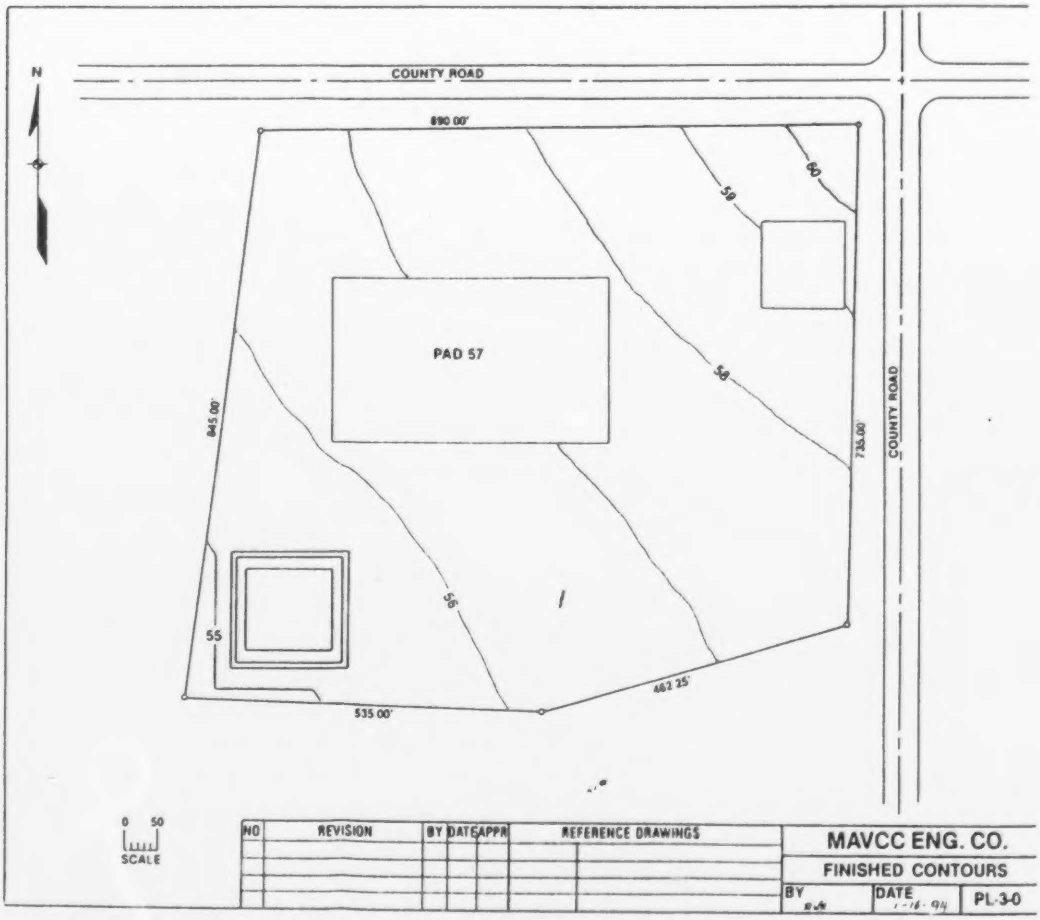
3. Characteristics of a finished contour drawing

a. A finished contour drawing shows new contour line elevations.

b. The finished contour drawing is drawn after the plot plan is approved, and is usually drawn by the company's civil department.

c. The major contribution of the finished contour drawing is that it helps determine the amount of major dirt work that needs to be done in the plant and on site.

Finished Contour Drawing


N
COUNTY ROAD
890.00'
60
59
58
PAD 57
845.00'
735.00'
COUNTY ROAD
56
55
535.00'
462.25'
0 50
SCALE
NO
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
FINISHED CONTOURS
BY
DATE
1-16-94
PL-3-0

Information Sheet

4. Information found on a plot plan

a. The equipment legend on a plot plan lists all equipment item numbers from mechanical and utility flow diagrams, describes all equipment, and gives a reference number which corresponds to the number in the drawing.

b. Boundaries and equipment are shown on a plot plan, and all equipment from flow diagrams is located and drawn to scale inside plant boundaries with a reference number corresponding to the equipment legend.

c. Access roads and building do not appear on flow diagrams, but they should be on plot plans.

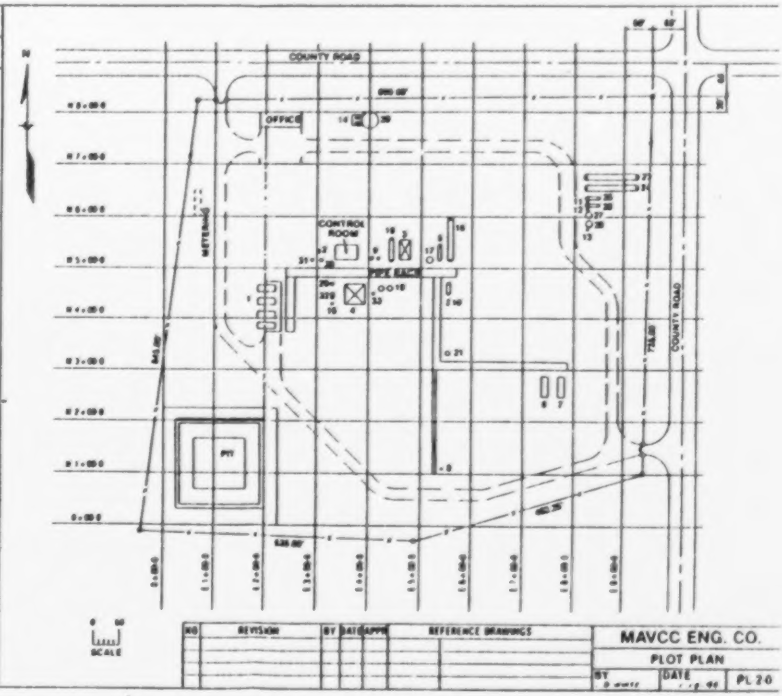
d. A north arrow and a coordinate system should be included on a plot plan.

e. If the plot plan will be microfilmed, a bar scale should be included.

Plot Plan with Equipment Legend

EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C 1A/D	GAS COMPRESSORS
2	C 2	AIR COMPRESSOR
3	AC 1	DEPROP OVHD COOLER
4	AC 2	GAS COOLER
5	E 1	DEPROP REBOILER
6	H 1	HOT OIL FURNACE
7	H 2	REGENERATION GAS HEATER
8	M 1	FLARE STACK
9	P 1A/B	DEPROP REFLUX PROD PUMPS
10	P 2A/B	HOT OIL PUMPS
11	P 3	GLYCOL WATER PUMP
12	P 4	LUBE OIL PUMP
13	P 5	HEATING OIL PUMP
14	P 6A/B	FIREWATER PUMPS
15	P 7	SLOP OIL PUMP
16	V 1	INLET RECEIVER
17	V 2	DEPROPANIZER
18	V 3	DEPROP OVHD ACCUM
19	V 4A/B	DEHYDRATORS
20	V 5	LUBE OIL SCRUBBER
21	V 6	FUEL GAS SCRUBBER
22	V 7	HOT OIL SURGE TANK
23	V 8	PROPANE STORAGE
24	V 9	DRIP GAS STORAGE
25	V 10	GLYCOL WATER STOR
26	V 11	LUBE OIL STORAGE
27	V 12	SLOP OIL STORAGE
28	V 13	HEATING OIL STORAGE
29	V 14	FIREWATER STORAGE
30	V 15	INSTRUMENT AIR TANK
31	V 16	STARTING AIR TANK
32	V 17	SLOP OIL SEPARATOR
33	F 1	MOLE SIEVE FILTER



Information Sheet

5. Purposes of a plot plan

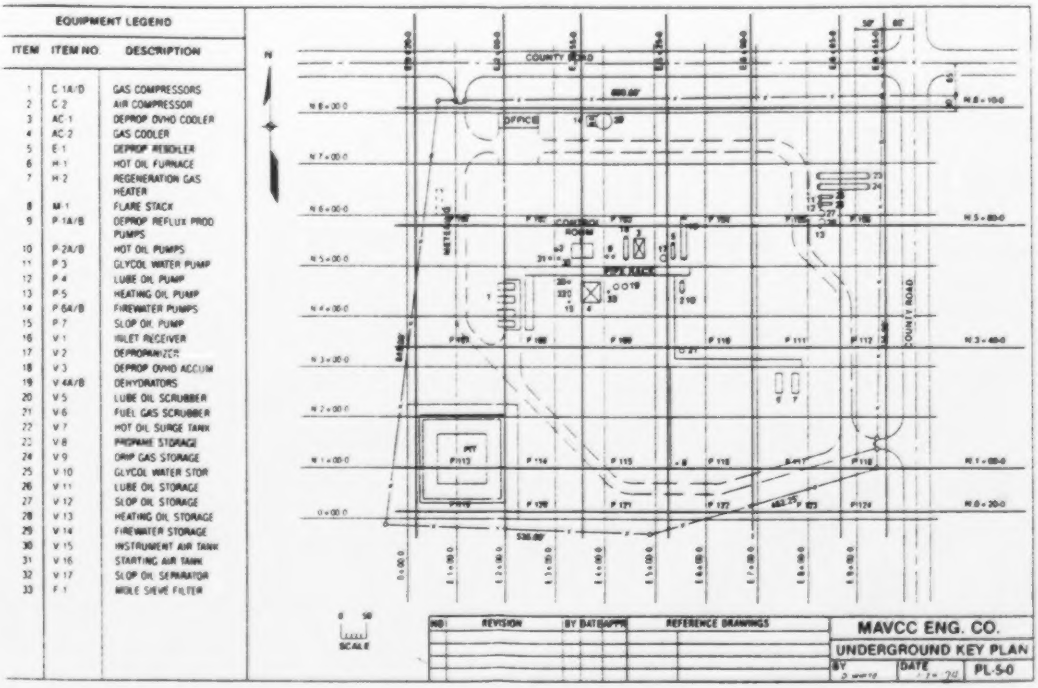
a. A plot plan shows the general arrangement of a plant and can be used with an existing contour drawing to develop the finished graded contour drawing.

b. A plot plan is used to make an area key index plan and an underground area key index plan.

c. A plot plan is used to make all of the system layout plans including single line pipe layout drawings of major lines and equipment.

d. Generally, the plot plan is used for locating equipment in a plant and for communicating information about the plant to interested parties.

Plot Plan



EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C 1A/D	GAS COMPRESSORS
2	C 2	AIR COMPRESSOR
3	AC 1	DEPROP OVHD COOLER
4	AC 2	GAS COOLER
5	E 1	DEPROP REBOILER
6	H 1	HOT OIL FURNACE
7	H 2	REGENERATION GAS HEATER
8	M 1	FLARE STACK
9	P 1A/B	DEPROP REFLUX PROD PUMPS
10	P 2A/B	HOT OIL PUMPS
11	P 3	GLYCOL WATER PUMP
12	P 4	LUBE OIL PUMP
13	P 5	HEATING OIL PUMP
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16	V 1	INLET RECEIVER
17	V 2	DEPROPANIZER
18	V 3	DEPROP OVHD ACCUM
19	V 4A/B	DEHYDRATORS
20	V 5	LUBE OIL SCRUBBER
21	V 6	FUEL GAS SCRUBBER
22	V 7	HOT OIL SURGE TANK
23	V 8	PROPANE STORAGE
24	V 9	DRIP GAS STORAGE
25	V 10	GLYCOL WATER STOR
26	V 11	LUBE OIL STORAGE
27	V 12	SLOP OIL STORAGE
28	V 13	HEATING OIL STORAGE
29	V 14	FIREWATER STORAGE
30	V 15	INSTRUMENT AIR TANK
31	V 16	STARTING AIR TANK
32	V 17	SLOP OIL SEPARATOR
33	F 1	MOLE SIEVE FILTER

N
COUNTY ROAD
OFFICE
CONTROL ROOM
PIPE RACK
PIT
COUNTY ROAD
0 50
SCALE
NO.
REVISION
BY
DATE
APP.
REFERENCE DRAWINGS
MAVCC ENG. CO.
UNDERGROUND KEY PLAN
BY
DATE
PL-5-0

Information Sheet

6. Characteristics of an area key index plan

a. An area key index plan is a layer on a plot plan with a grid or match lines added to the drawing to divide the area into smaller drawings.

b. The smaller drawings on an area key index plan should be large enough to provide detailed information.

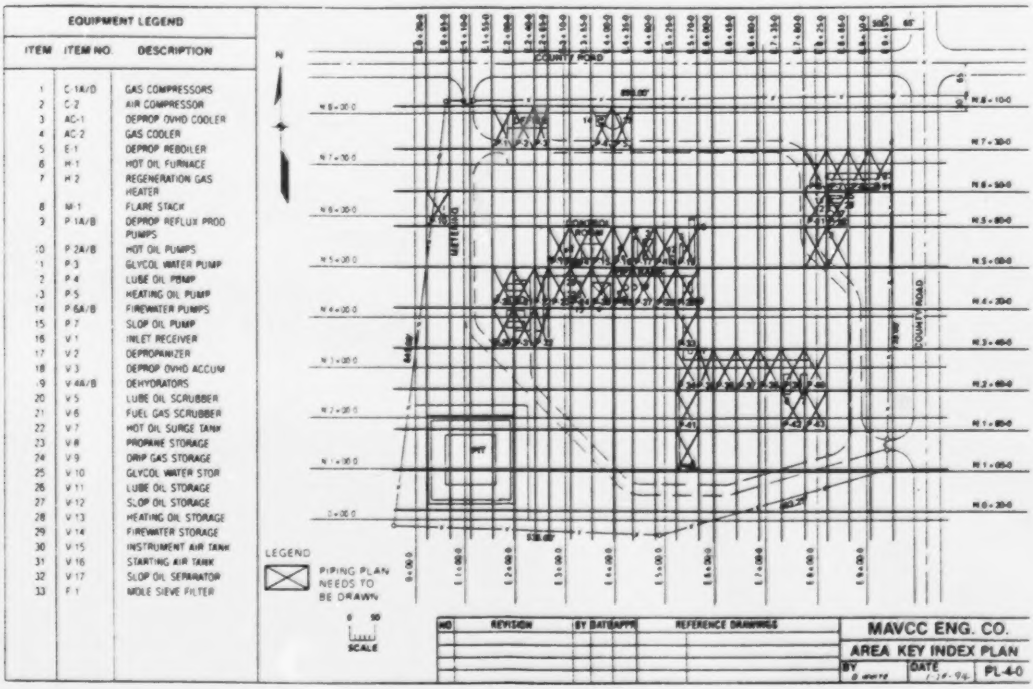
c. Each grid line has a coordinate number determined from the benchmark.

d. Each coordinate line number includes direction, number of hundred feet, number of feet, and number of inches.

Example: N.1 + 20 – 0 means north 120 feet and 0 inches
E.4 + 25 – 0 means east 425 feet and 0 inches

e. Each area that needs a detailed drawing made of it will have an X on the drawing to indicate the need for a piping plan, and each piping plan will have a drawing number that references the area key index plan.

Area Key Index Plan



EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER

NO	REVISION	BY	DATE	APPR	REFERENCE DRAWINGS

MAVCC ENG. CO.
AREA KEY INDEX PLAN
BY: B. White
DATE: 1-18-94
PL-4-0

N
COUNTY ROAD
COUNTY ROAD
CONTROL ROOM
METERING
PIT
LEGEND
PIPING PLAN NEEDS TO BE DRAWN
0 50
SCALE
N 8+10-0
N 7+30-0
N 6+50-0
N 5+80-0
N 5+00-0
N 4+30-0
N 3+40-0
N 2+60-0
N 1+80-0
N 1+00-0
N 0+20-0
E 0+00-0
E 1+00-0
E 2+00-0
E 3+00-0
E 4+00-0
E 5+00-0
E 6+00-0
E 7+00-0
E 8+00-0
E 9+00-0

BEST COPY AVAILABLE

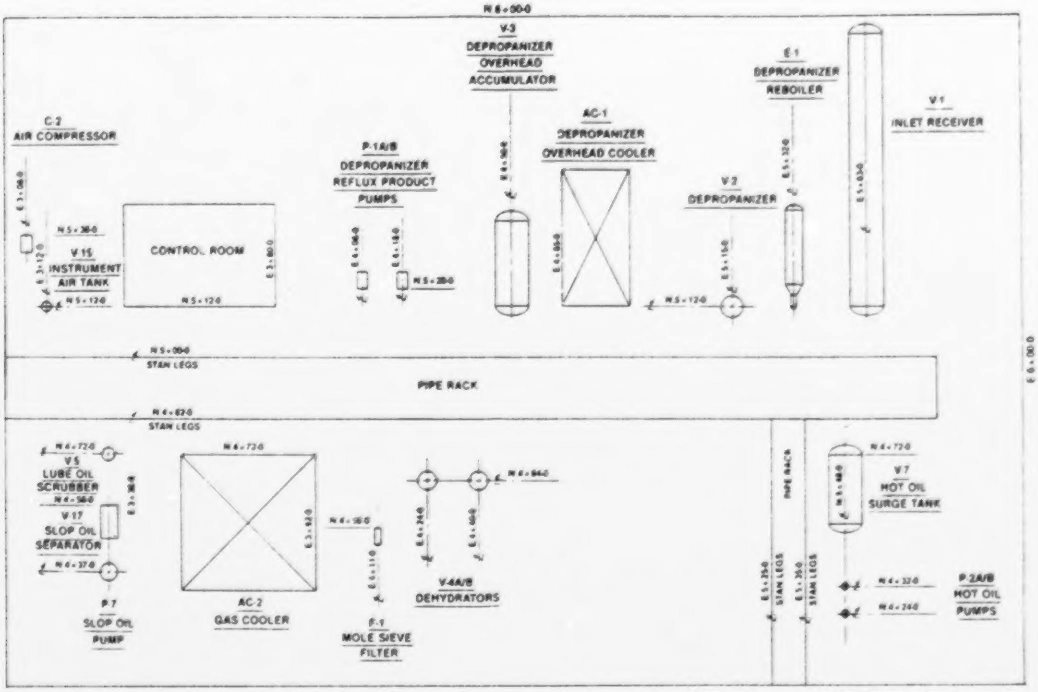
Information Sheet

7. Characteristics of an equipment layout sheet

a. An equipment layout sheet should have a legend with item numbers and equipment descriptions.

b. A layout sheet is used to determine equipment coordinates.

Equipment Layout Sheet


N 6+00-0
V-3
DEPROPANIZER
OVERHEAD
ACCUMULATOR
E-1
DEPROPANIZER
REBOILER
V-1
INLET RECEIVER
C-2
AIR COMPRESSOR
AC-1
DEPROPANIZER
OVERHEAD COOLER
P-1A/B
DEPROPANIZER
REFLUX PRODUCT
PUMPS
V-2
DEPROPANIZER
N 5+36-0
V-15
INSTRUMENT
AIR TANK
N 5+12-0
CONTROL ROOM
N 5+12-0
N 5+28-0
N 5+12-0
N 5+00-0
STAN LEGS
PIPE RACK
E 6+00-0
N 4+62-0
STAN LEGS
N 4+72-0
V-5
LUBE OIL
SCRUBBER
V-17
SLOP OIL
SEPARATOR
N 4+37-0
P-7
SLOP OIL
PUMP
N 4+72-0
AC-2
GAS COOLER
F-1
MOLE SIEVE
FILTER
V-4A/B
DEHYDRATORS
PIPE RACK
STAN LEGS
STAN LEGS
N 4+72-0
V-7
HOT OIL
SURGE TANK
N 4+32-0
N 4+24-0
P-2A/B
HOT OIL
PUMPS

Information Sheet

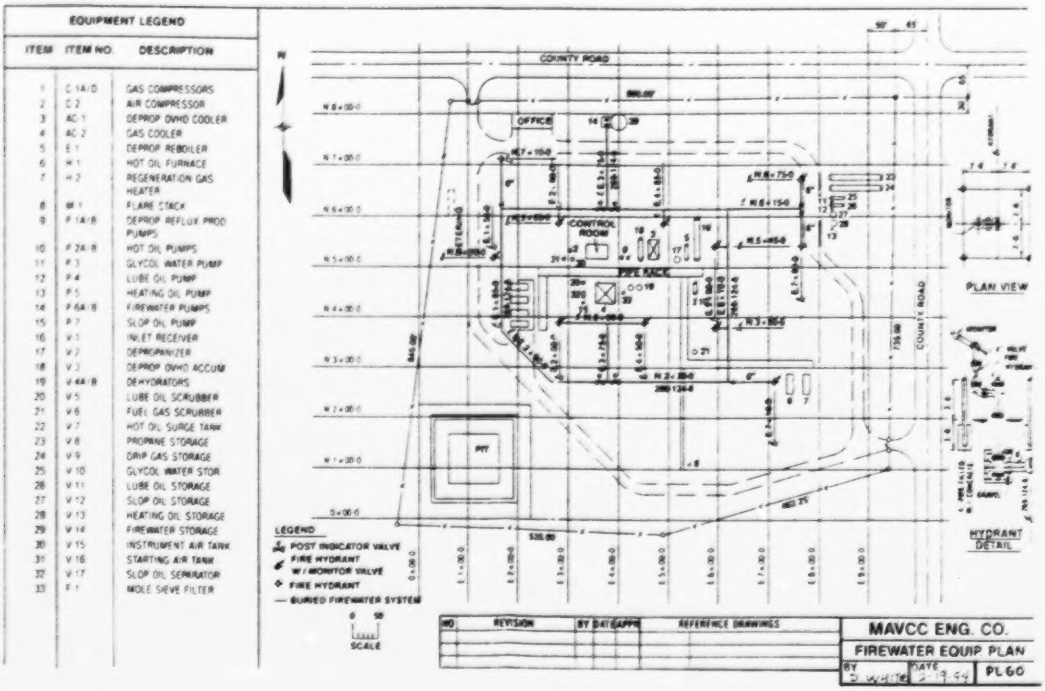
8. Characteristics of an underground area key index plan

a. An underground area key index is on a layer of the plot plan with a grid added to the layer to divide the area into blocks called underground piping plans.

b. Each grid line has a coordinate number determined from the benchmark, and each block has a drawing number.

c. Underground piping plans can be drawn only when all piping plans are completed for the underground piping area.

Underground Area Key Index Plan



EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C 1A/D	GAS COMPRESSORS
2	C 2	AIR COMPRESSOR
3	AC 1	DEPROP OVHD COOLER
4	AC 2	GAS COOLER
5	E 1	DEPROP REBOILER
6	H 1	HOT OIL FURNACE
7	H 2	REGENERATION GAS HEATER
8	M 1	FLARE STACK
9	P 1A/B	DEPROP REFLUX PROD PUMPS
10	P 2A/B	HOT OIL PUMPS
11	P 3	GLYCOL WATER PUMP
12	P 4	LUBE OIL PUMP
13	P 5	HEATING OIL PUMP
14	P 6A/B	FIREWATER PUMPS
15	P 7	SLOP OIL PUMP
16	V 1	INLET RECEIVER
17	V 2	DEPROPANIZER
18	V 3	DEPROP OVHD ACCUM
19	V 4A/B	DEHYDRATORS
20	V 5	LUBE OIL SCRUBBER
21	V 6	FUEL GAS SCRUBBER
22	V 7	HOT OIL SURGE TANK
23	V 8	PROPANE STORAGE
24	V 9	DRIP GAS STORAGE
25	V 10	GLYCOL WATER STOR
26	V 11	LUBE OIL STORAGE
27	V 12	SLOP OIL STORAGE
28	V 13	HEATING OIL STORAGE
29	V 14	FIREWATER STORAGE
30	V 15	INSTRUMENT AIR TANK
31	V 16	STARTING AIR TANK
32	V 17	SLOP OIL SEPARATOR
33	F 1	MOLE SIEVE FILTER

COUNTY ROAD
OFFICE
CONTROL ROOM
PIPE RACK
PIT
COUNTY ROAD
PLAN VIEW
HYDRANT DETAIL
N 8+00.0
N 7+00.0
N 6+00.0
N 5+00.0
N 4+00.0
N 3+00.0
N 2+00.0
N 1+00.0
0+00.0
0+00.0
E 1+00.0
E 2+00.0
E 3+00.0
E 4+00.0
E 5+00.0
E 6+00.0
E 7+00.0
E 8+00.0
E 9+00.0
LEGEND
POST INDICATOR VALVE
FIRE HYDRANT W/ MONITOR VALVE
FIRE HYDRANT
BURIED FIREWATER SYSTEM
0 50
SCALE
NO.
REVISION
BY
DATE
APPR
REFERENCE DRAWINGS
MAVCC ENG. CO.
FIREWATER EQUIP PLAN
BY
D WHITE
DATE
2-19-94
PL60

Information Sheet

9. Characteristics of a firewater and fire fighting equipment plan

a. A fire fighting equipment plan is a layer on the plot plan which shows the routing of firewater lines with coordinates.

b. The fire fighting plan shows the location of all fire hydrants with coordinates E and W and N and S, and the location of all fire hydrants with monitors and spray radiuses with coordinates E and W and N and S.

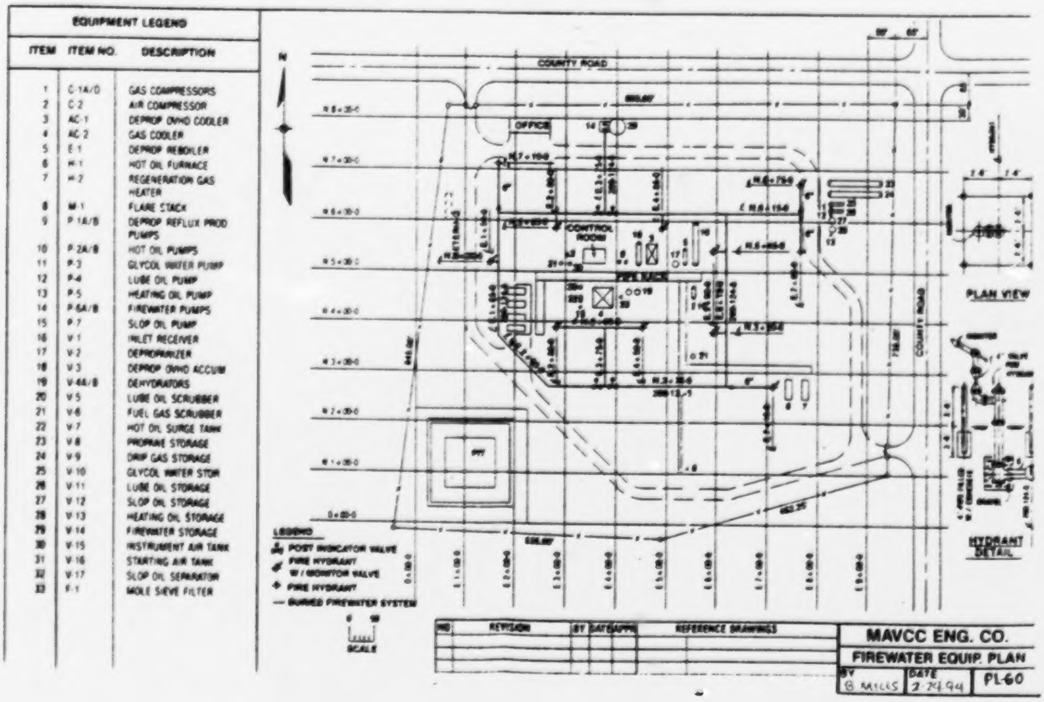
c. The fire fighting plan shows the location of all fire valves, all line numbers, and line sizes, and includes all line reducers.

d. The fire fighting plan includes the minimum cover along with a detailed plan view of a fire hydrant with a guard post, which is a steel pipe used to protect something.

e. The fire fighting plan also shows a detailed elevation view of a fire hydrant, and has a legend describing all new equipment or lines placed on the drawing.

f. The fire fighting plan shows all fire fighting equipment on the drawing located with a referencing symbol which relates to the table.

Firewater and Fire Fighting Equipment Plan



EQUIPMENT LEGEND

ITEM	ITEM NO.	DESCRIPTION
1	C-1A/D	GAS COMPRESSORS
2	C-2	AIR COMPRESSOR
3	AC-1	DEPROP OVHD COOLER
4	AC-2	GAS COOLER
5	E-1	DEPROP REBOILER
6	H-1	HOT OIL FURNACE
7	H-2	REGENERATION GAS HEATER
8	M-1	FLARE STACK
9	P-1A/B	DEPROP REFLUX PROD PUMPS
10	P-2A/B	HOT OIL PUMPS
11	P-3	GLYCOL WATER PUMP
12	P-4	LUBE OIL PUMP
13	P-5	HEATING OIL PUMP
14	P-6A/B	FIREWATER PUMPS
15	P-7	SLOP OIL PUMP
16	V-1	INLET RECEIVER
17	V-2	DEPROPANIZER
18	V-3	DEPROP OVHD ACCUM
19	V-4A/B	DEHYDRATORS
20	V-5	LUBE OIL SCRUBBER
21	V-6	FUEL GAS SCRUBBER
22	V-7	HOT OIL SURGE TANK
23	V-8	PROPANE STORAGE
24	V-9	DRIP GAS STORAGE
25	V-10	GLYCOL WATER STOR
26	V-11	LUBE OIL STORAGE
27	V-12	SLOP OIL STORAGE
28	V-13	HEATING OIL STORAGE
29	V-14	FIREWATER STORAGE
30	V-15	INSTRUMENT AIR TANK
31	V-16	STARTING AIR TANK
32	V-17	SLOP OIL SEPARATOR
33	F-1	MOLE SIEVE FILTER

LEGEND
- POST INDICATOR VALVE
- FIRE HYDRANT W / MONITOR VALVE
- FIRE HYDRANT
- BURIED FIREWATER SYSTEM

NO	REVISION	BY	DATE	APP	REFERENCE DRAWINGS

MAVCC ENG. CO.
FIREWATER EQUIP. PLAN
BY B MILLS
DATE 2-24-94
PL-60

Plot Plans and Equipment Layout
Unit 9

Assignment Sheet 1—Draw a Partial Plot Plan

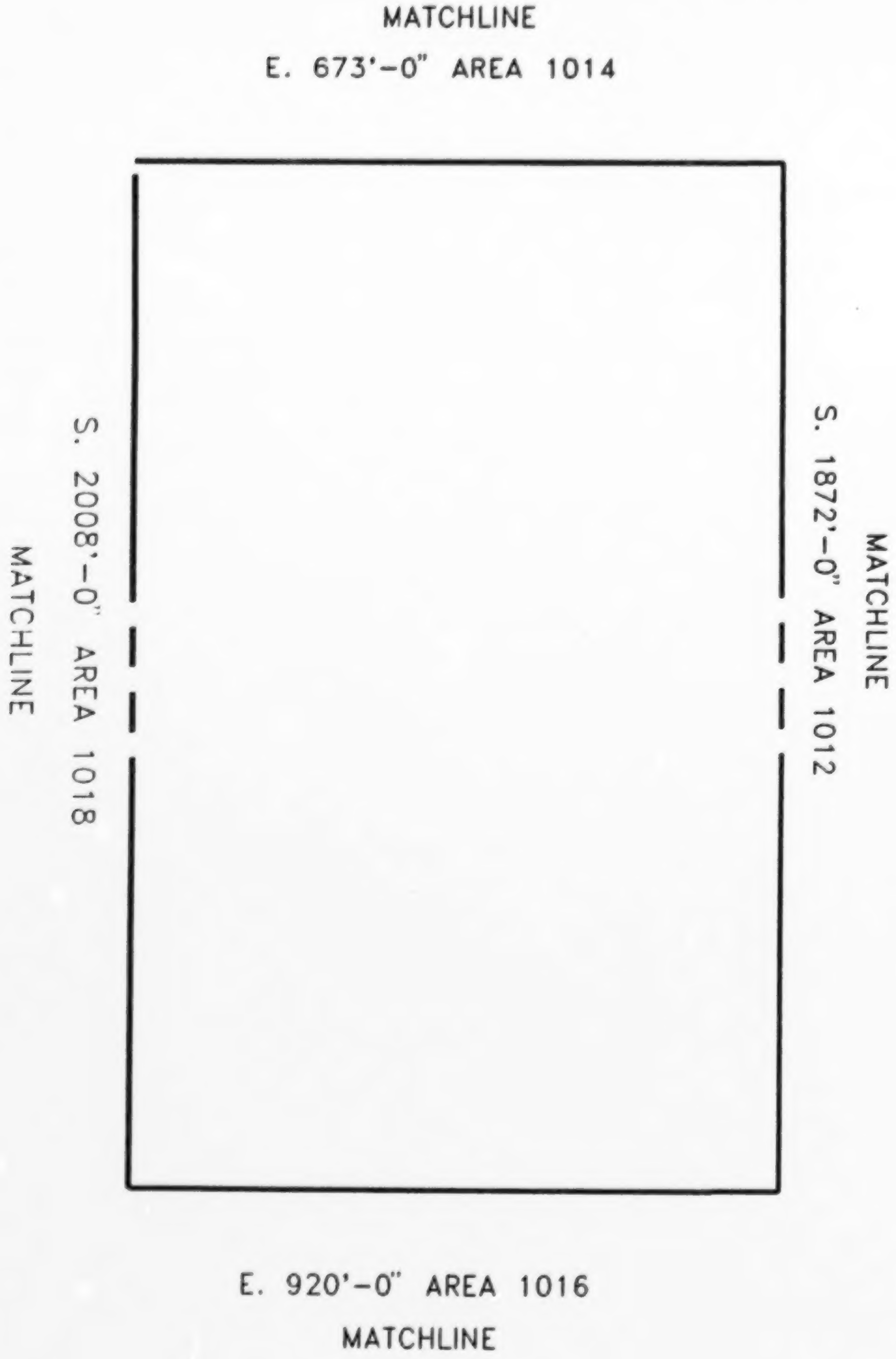
Name ________________________ Overall Rating ____________

Evaluation criteria	**Rating**
Draw to scale	______
Equipment in proper locations	______
Coordinates dimensioned correctly	______
Complete title block information	______
Equipment on proper layers	______

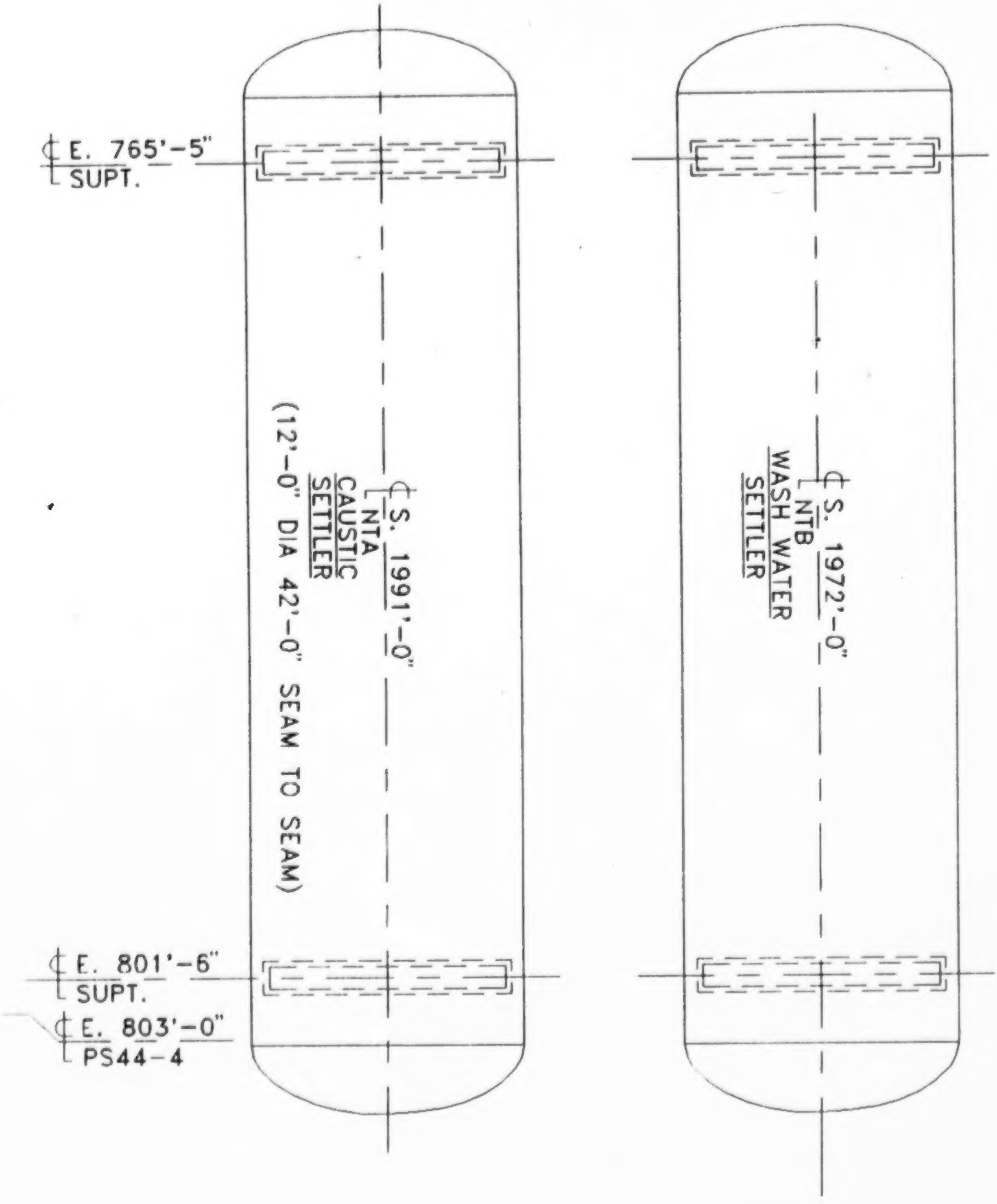
Directions: Use the attached matchline of a plot plan to draw a D size title block using a scale of 1/8″ = 1′-0″. Reference other attached drawings and add the following equipment at the proper scale and coordinates.

NTA-CAUSTIC SETTLER
NTB-WASH WATER SETTLER
DCS BLDG
HT-PROD-PMPA/B
NT-PMPA/B
NT-PMAC
ANALYZER BLDG
PIPE RACK
ISM-CHG-PMPA/B
HEC-HYDROTREATER EFFLUENT COOLER
HFD-HYDROTREATER FLASH DRUM
HFE 1/2-HYDROTREATER FEED/EFFLUENT EXCHANGER #1
HFE 3-HYDROTREATER FEED/EFFLUENT EXCHANGER #2
PUA/B POLISHING UNITS
HTCR-HYDROTREATER RECYCLE COMPRESSOR

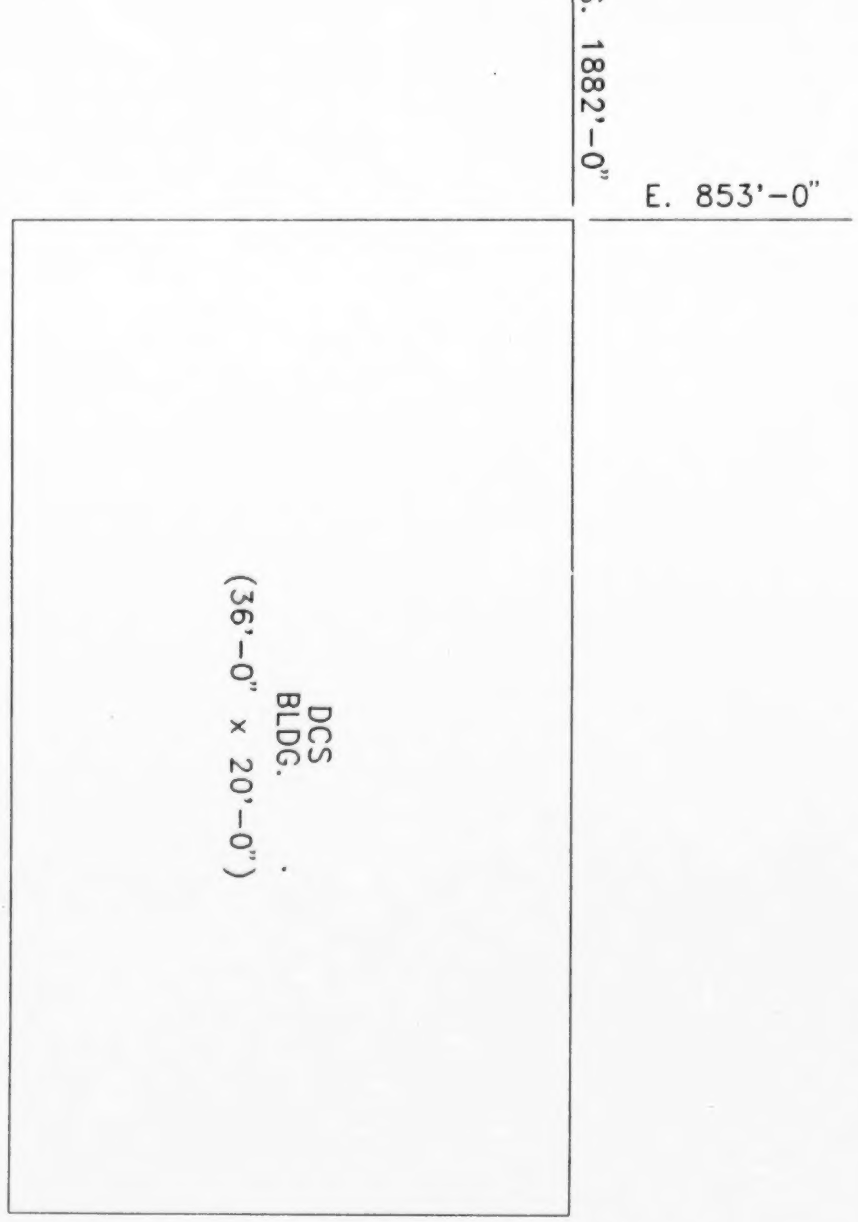
Assignment Sheet 1 (Page 1 of 13)


MATCHLINE
E. 673'-0" AREA 1014
S. 2008'-0" AREA 1018
MATCHLINE
S. 1872'-0" AREA 1012
MATCHLINE
E. 920'-0" AREA 1016
MATCHLINE

Assignment Sheet 1 (Page 2 of 13)

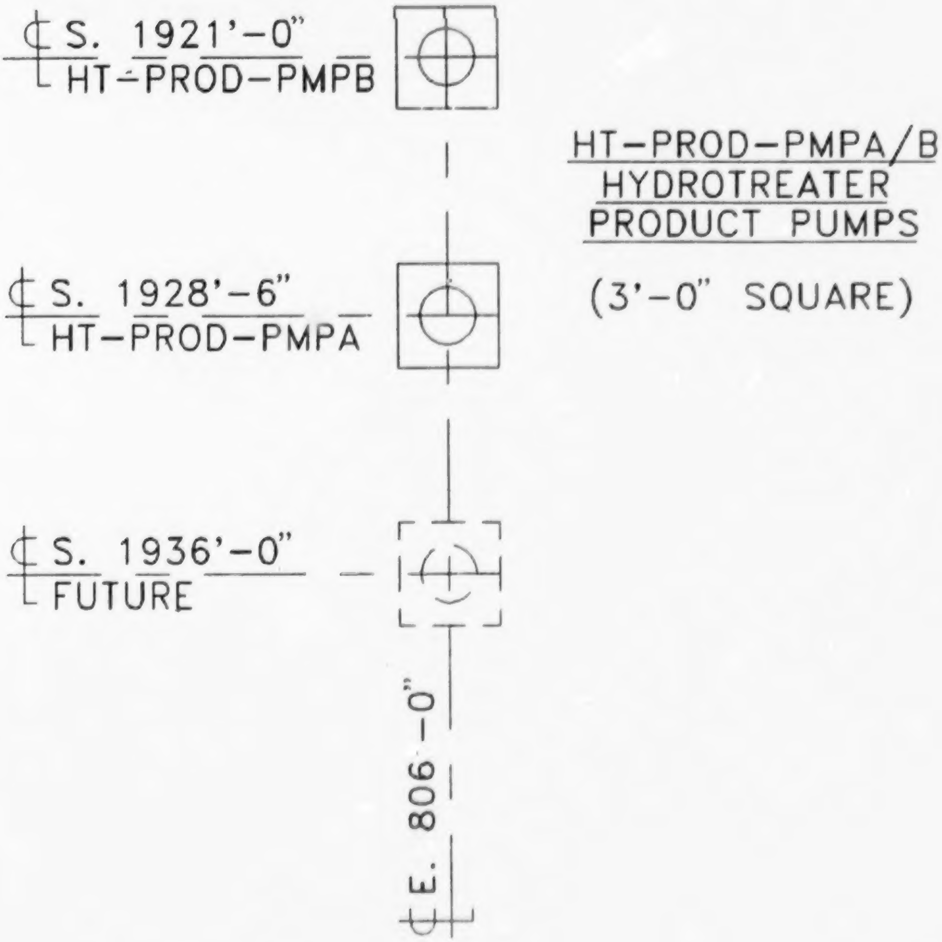

℄ E. 765'-5"
SUPT.
℄ S. 1991'-0"
NTA
CAUSTIC
SETTLER
(12'-0" DIA 42'-0" SEAM TO SEAM)
℄ S. 1972'-0"
NTB
WASH WATER
SETTLER
℄ E. 801'-6"
SUPT.
℄ E. 803'-0"
PS44-4

Assignment Sheet 1 (Page 3 of 13)

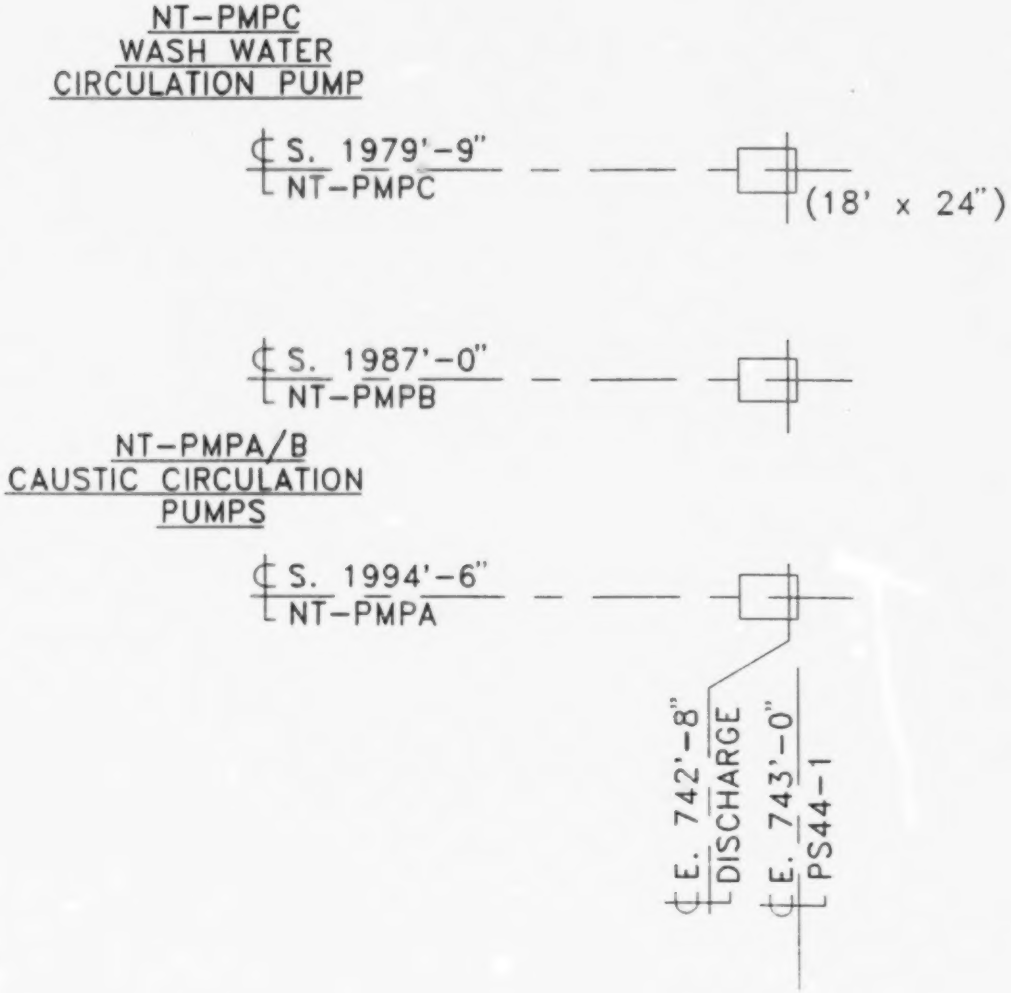

S. 1882'-0"
E. 853'-0"
DCS
BLDG.
(36'-0" x 20'-0")

688

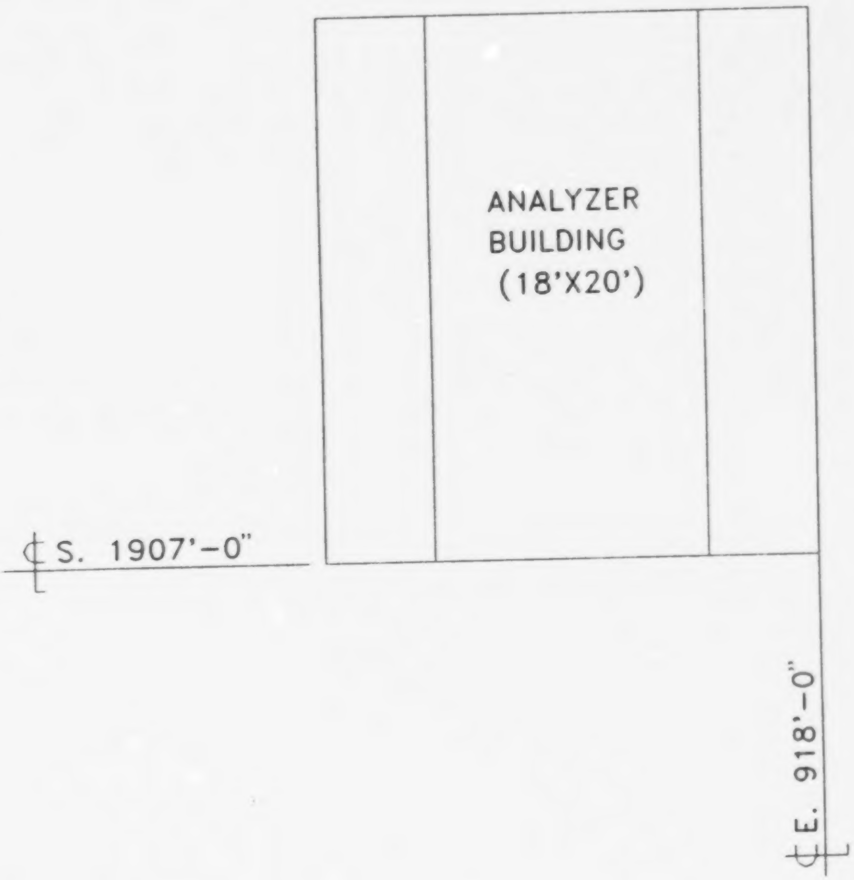
Assignment Sheet 1 (Page 4 of 13)


℄ S. 1921'-0"
HT-PROD-PMPB
HT-PROD-PMPA/B
HYDROTREATER
PRODUCT PUMPS
(3'-0" SQUARE)
℄ S. 1928'-6"
HT-PROD-PMPA
℄ S. 1936'-0"
FUTURE
℄ E. 806'-0"

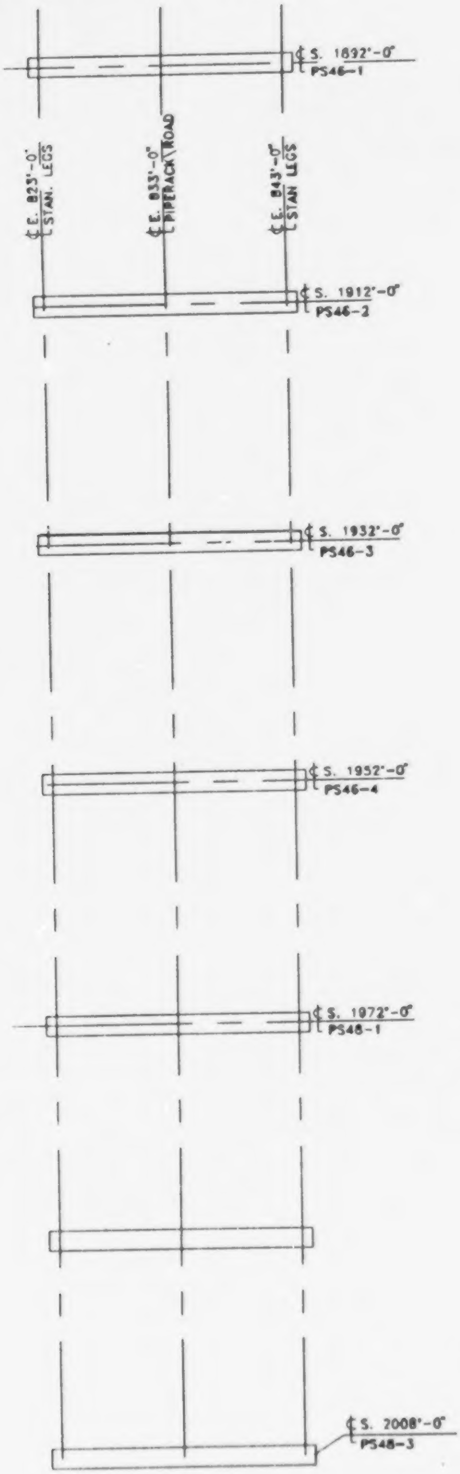
Assignment Sheet 1 (Page 5 of 13)


NT-PMPC
WASH WATER
CIRCULATION PUMP
℄ S. 1979'-9"
NT-PMPC
(18' x 24")
℄ S. 1987'-0"
NT-PMPB
NT-PMPA/B
CAUSTIC CIRCULATION
PUMPS
℄ S. 1994'-6"
NT-PMPA
℄ E. 742'-8"
DISCHARGE
℄ E. 743'-0"
PS44-1

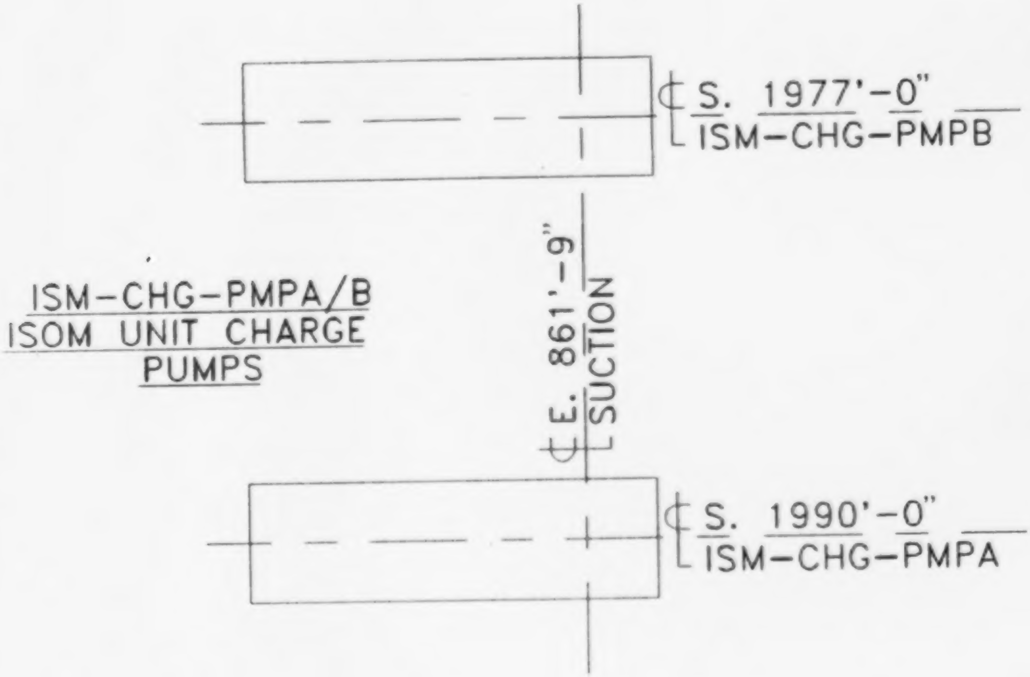
Assignment Sheet 1 (Page 6 of 13)


ANALYZER
BUILDING
(18'X20')
℄ S. 1907'–0"
℄ E. 918'–0"

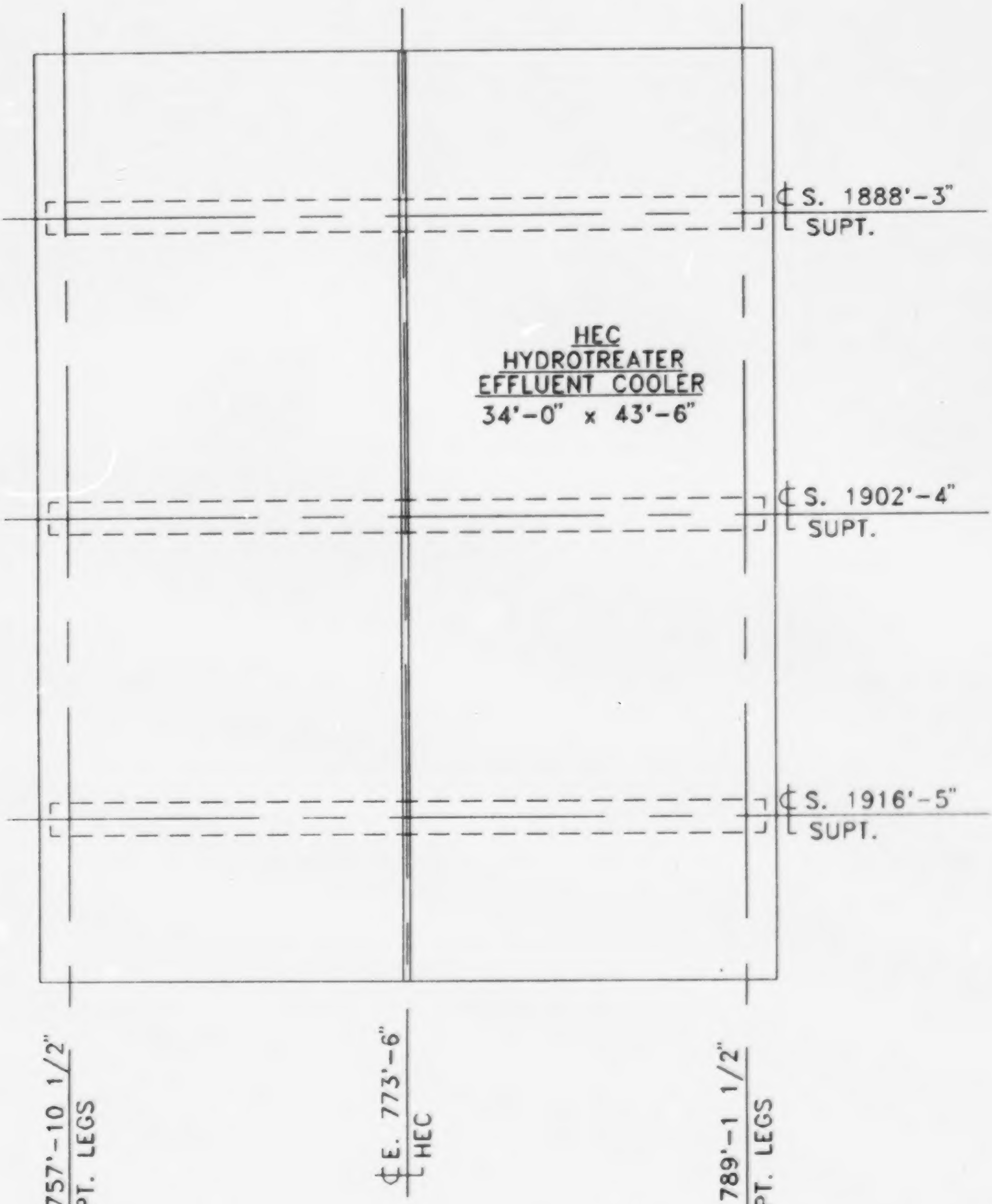
Assignment Sheet 1 (Page 7 of 13)


℄ S. 1892'-0"
PS46-1
℄ E. 823'-0"
STAN. LEGS
℄ E. 833'-0"
PIPERACK\ROAD
℄ E. 843'-0"
STAN LEGS
℄ S. 1912'-0"
PS46-2
℄ S. 1932'-0"
PS46-3
℄ S. 1952'-0"
PS46-4
℄ S. 1972'-0"
PS48-1
℄ S. 2008'-0"
PS48-3

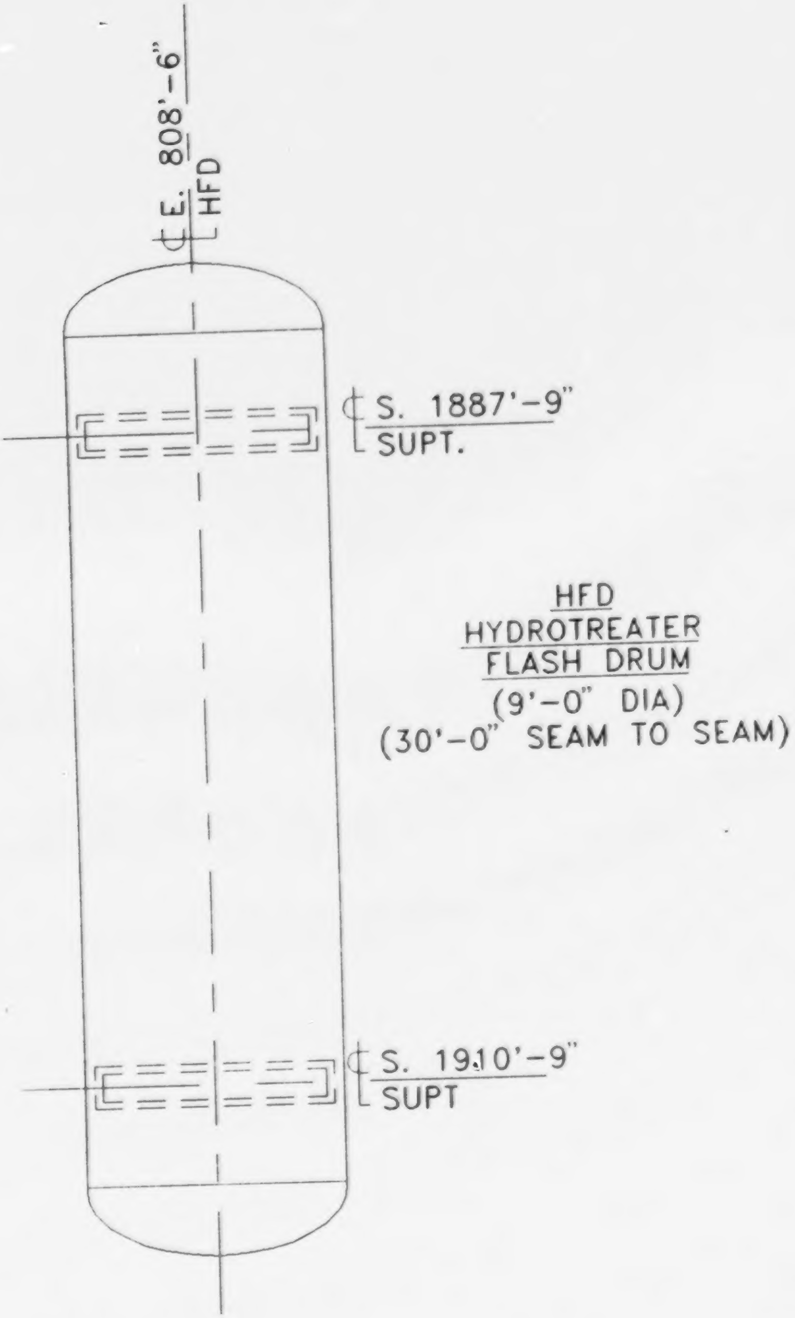
Assignment Sheet 1 (Page 8 of 13)


℄ S. 1977'-0"
ISM-CHG-PMPB
ISM-CHG-PMPA/B
ISOM UNIT CHARGE
PUMPS
℄ E. 861'-9"
SUCTION
℄ S. 1990'-0"
ISM-CHG-PMPA

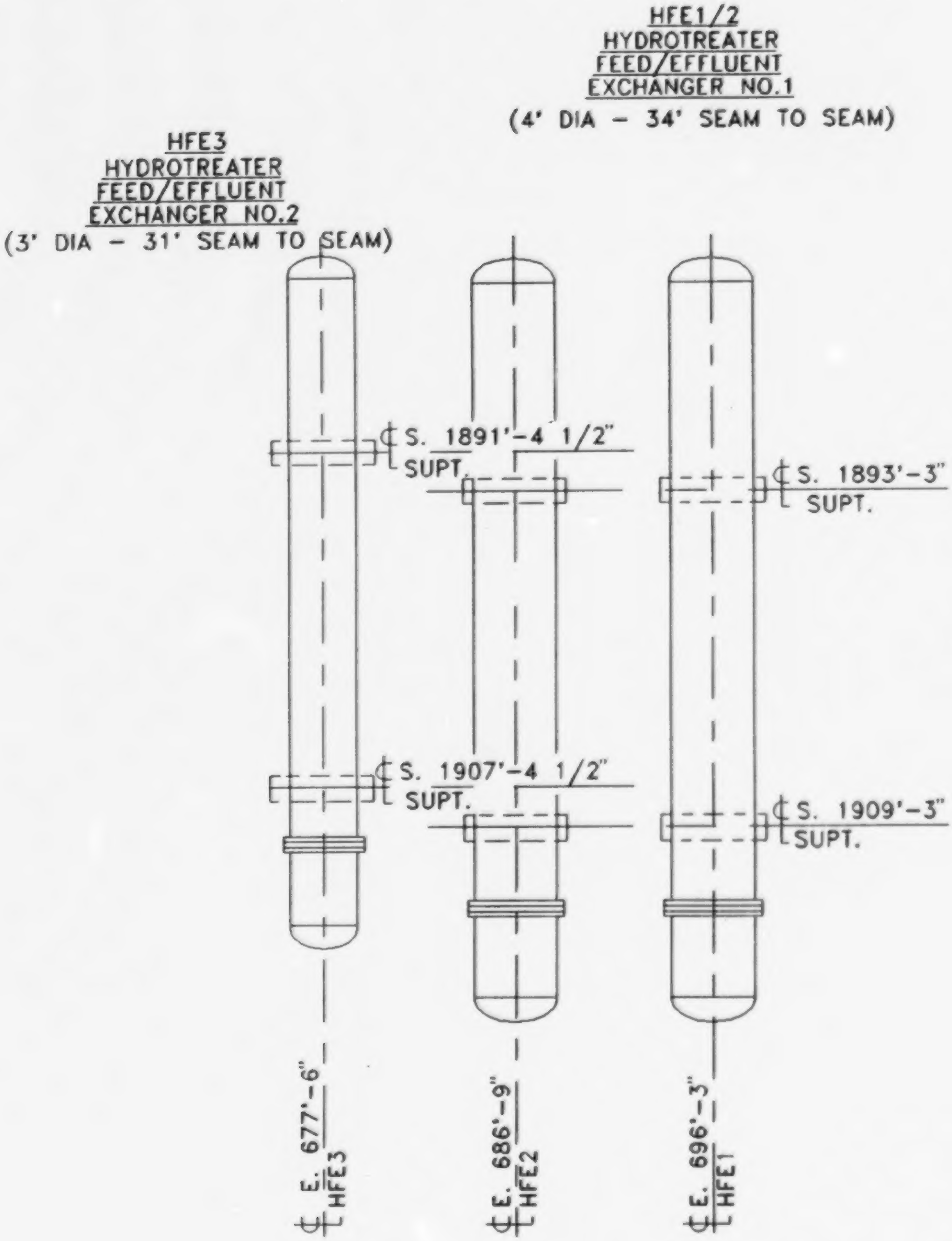
Assignment Sheet 1 (Page 9 of 13)


HEC
HYDROTREATER
EFFLUENT COOLER
34'-0" x 43'-6"
℄ S. 1888'-3" SUPT.
℄ S. 1902'-4" SUPT.
℄ S. 1916'-5" SUPT.
℄ E. 757'-10 1/2" SUPT. LEGS
℄ E. 773'-6" HEC
℄ E. 789'-1 1/2" SUPT. LEGS

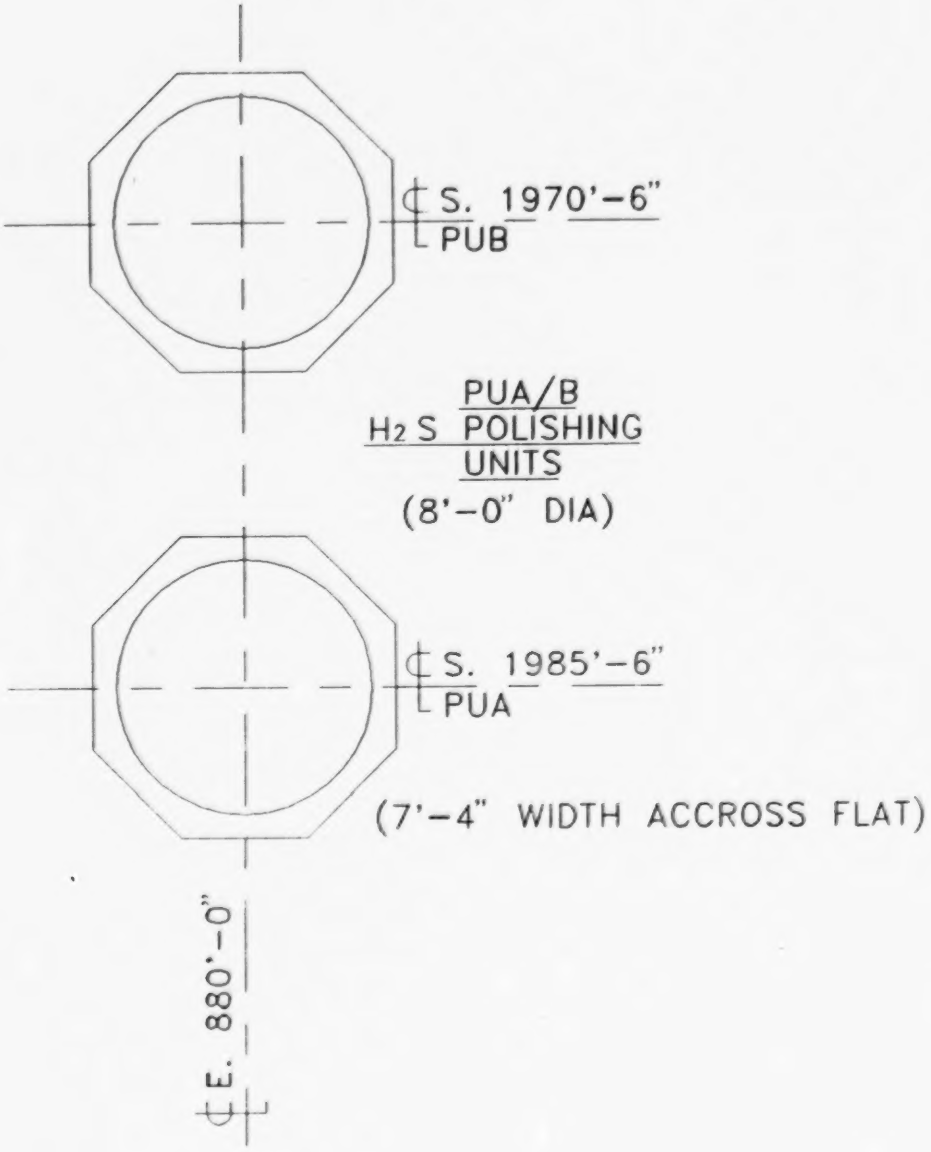
Assignment Sheet 1 (Page 10 of 13)


℄ E. 808'-6"
HFD
℄ S. 1887'-9"
SUPT.
HFD
HYDROTREATER
FLASH DRUM
(9'-0" DIA)
(30'-0" SEAM TO SEAM)
℄ S. 1910'-9"
SUPT

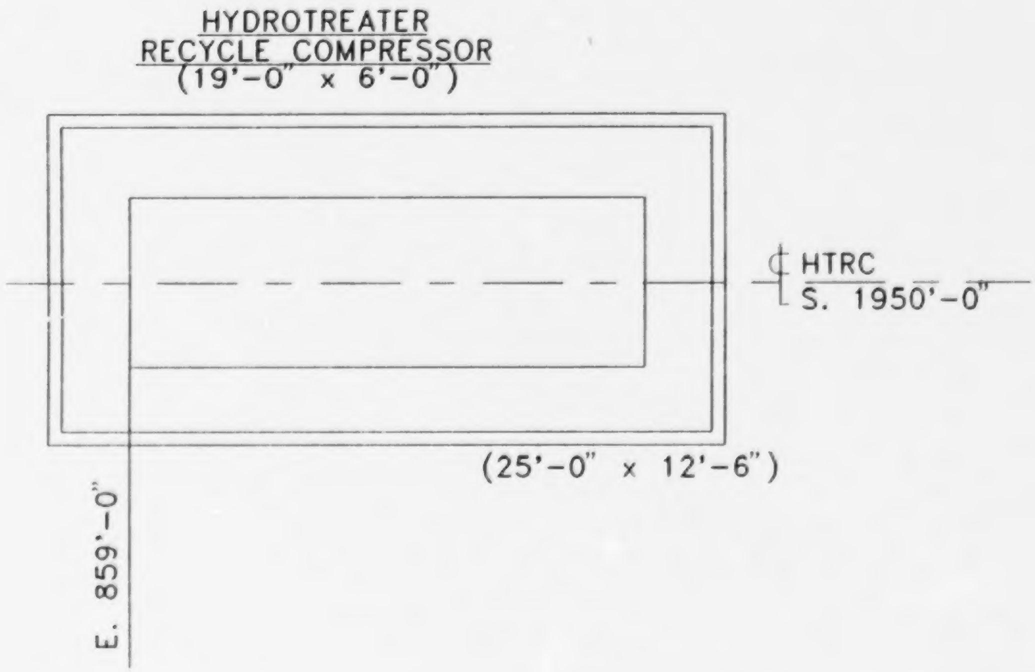
Assignment Sheet 1 (Page 11 of 13)


HFE1/2
HYDROTREATER
FEED/EFFLUENT
EXCHANGER NO.1
(4' DIA – 34' SEAM TO SEAM)
HFE3
HYDROTREATER
FEED/EFFLUENT
EXCHANGER NO.2
(3' DIA – 31' SEAM TO SEAM)
℄ S. 1891'-4 1/2"
SUPT.
℄ S. 1893'-3"
SUPT.
℄ S. 1907'-4 1/2"
SUPT.
℄ S. 1909'-3"
SUPT.
℄ E. 677'-6"
HFE3
℄ E. 686'-9"
HFE2
℄ E. 696'-3"
HFE1

Assignment Sheet 1 (Page 12 of 13)


℄ S. 1970'-6"
PUB
PUA/B
H2 S POLISHING
UNITS
(8'-0" DIA)
℄ S. 1985'-6"
PUA
(7'-4" WIDTH ACCROSS FLAT)
℄ E. 880'-0"

Assignment Sheet 1 (Page 13 of 13)


HYDROTREATER
RECYCLE COMPRESSOR
(19'-0" x 6'-0")
℄ HTRC
S. 1950'-0"
(25'-0" x 12'-6")
E. 859'-0"

Plot Plans and Equipment Layout
Unit 9

Assignment Sheet 2—Draw a Plot Plan

Name ______________________ Overall Rating ____________

Evaluation criteria	**Rating**
All components of plot plan properly treated	______
Correct scale used	______
Legend complete and correct	______
Lettering and general neatness	______

Directions: Your instructor will provide you with samples to reference and any special information required for you to draw a plot plan for a given site. Draw on "D" size vellum using a scale of 1″ = 50′. Follow other directions as indicated.

CAD Alert: Your CAD workstation will not only speed up your drawing for this assignment, you'll be able to type the equipment legend much faster than you could letter it.

a. To the left of the plot plan, make an equipment legend to include the following:

ITEM NO.	DESCRIPTION	ITEM NO.	DESCRIPTION
C-1A/D	GAS COMPRESSORS	V-3	DEPROP.
C-2	AIR COMPRESSOR	V-4A/B	DEHYDRATOR
AC-1	DEPROP. OVHD COOLER	V-5	LUBE OIL
AC-2	GAS COOLER	V-6	FUEL GAS
E-1	DEPROP. REBOILER	V-7	HOT OIL
H-1	HOT OIL FURNACE	V-8	PROPANE
H-2	REGENERATION GAS HEATER	V-9	DRIP GAS
M-1	FLARE STACK	V-10	GLYCOL
P-1A/B	DEPROP. REFLUX PROD. PUMPS	V-11	LUBE OIL
P-2A/B	HOT OIL PUMPS	V-12	SLOP OIL
P-3	GLYCOL WATER PUMP	V-13	HEATING OIL
P-4	LUBE OIL PUMP	V-14	FIREWATER
P-5	HEATING OIL PUMP	V-15	INSTRUMENT
P-6A/B	FIREWATER PUMPS	V-16	STARTING AIR
P-7	SLOP OIL PUMP	V-17	SLOP OIL
V-1	INLET RECEIVER	F-1	MOLE SIEVE
V-2	DEPROPANIZER		

Assignment Sheet 2

ITEM NO.	DESCRIPTION	SIZE
V-4A/B	DEHYDRATORS	6′ Dia
V-5	LUBE OIL SCRUBBER	4′ Dia
V-6	FUEL GAS SCRUBBER	4′ Dia
V-7	HOT OIL SURGE TANK	10′-20′
V-8	PROPANE STORAGE	12′-100′
V-9	DRIP GAS STORAGE	12′-100′
V-10	GLYCOL WATER STOR.	5′-25′
V-11	LUBE OIL STORAGE	5′-25′
V-12	SLOP OIL STORAGE	10′ Dia
V-13	HEATING OIL STORAGE	10′ Dia
V-14	FIREWATER STORAGE	30′ Dia
V-15	INSTRUMENT AIR TANK	3′ Dia
V-16	STARTING AIR TANK	3′ Dia
V-17	SLOP OIL SEPARATOR	5′-10′
F-1	MOLE SIEVE FILTER	2′-5′

b. Draw all plant roads 20′-0″ wide with a 40′-0″ turning radius.

c. Draw main pipe rack 18′-0″ wide.

d. Draw compressor header rack 14′-0″ wide.

e. Draw pit 100′ × 100′ at base with 3 × 1 slope banks.

f. Draw office building 30′ × 80′.

g. Draw control room 30′ × 45′.

h. Draw on plant boundaries a fence with gate at all entries.

i. Draw all gas compressors in a building 30′ × 100′.

j. Draw metering area 10′ × 50′.

k. Draw all firewater pumps in a 3-sided building 20′ × 15′ with the fourth (open) side curved against the firewater storage.

Note: All line weights on plot plan are the same except for the coordinate system.